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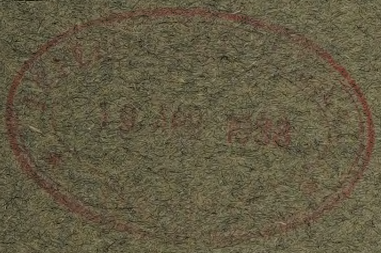

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FURTHER STUDY OF THE INFLUENCE OF HEAT AND CARBON DIOXIDE ON THE DEVELOPMENT OF CARABAO MANGO BUDS

By F. G. GALANG and JULIAN A. AGATI
Of the Horticulture Section

TWO TEXT FIGURES

This paper gives the results of a further study of the influence of heat and smoke on the development of Carabao mango buds, *Mangifera indica* L., as published in the Philippine Journal of Agriculture, Vol. 7, No. 2, Second Quarter, 1936(2). In that paper it was reported that the development of the Carabao mango buds was accelerated with the application of carbon monoxide and carbon dioxide with heat in moderate amounts than with heat alone. The heat referred to here was liberated by the fire built under the trees, using charcoal as fuel. Thus, the heat produced was found to contain also a certain quantity of gases—carbon monoxide and carbon dioxide. Moreover, the smoke applied through a condenser carried also a certain amount of heat with the gases. In that experiment it was not quite possible to account separately the effects of cargon dioxide or other gas factors from the heat factor on the bud development of mango so that one may prove conclusively which one is responsible, the carbon dioxide or the heat, on the development of mango buds in smudging the trees. It was deemed necessary, therefore, to device means whereby a certain amount of heat could be

liberated alone without any accompanying smoke or gas; similarly, to obtain carbon dioxide apart from heat. To accomplish this, the use of an electric-heater and dry-ice was resorted to. The experiment under review had for its principal object the determination of the subsequent effects of heat produced by means of an electric heater and that of carbon dioxide liberated from dry-ice on the development of Carabao mango buds.

MATERIALS AND METHODS

The experiment was started during the latter part of January, 1936 and lasted till the middle of April of the same year, or a total of 72 days of actual observation, excepting Sundays and holidays. The same plants previously experimented with were used in this experiment. They consisted of grafted Carabao mangos that had flowered already in petroleum cans. These were repotted in half-galvanized empty calcium arsenate drums, and were about 3½ to 4 years old. There were seventeen of them and consecutively numbered from 1 to 17. These plants were divided into lots; namely, the dry-ice lot, the electric-heater lot and the control lot. Each lot or group of plants was placed a few meters away from the other in order to prevent any possible contamination of the carbon dioxide or the heat which was to be applied. Originally, the first and the second lots consisted of 5 plants each—Nos. 1, 11, 12, 15 and 19, and Nos. 5, 6, 13, 14 and 17, respectively, and 7 plants—Nos. 2 to 4 and 7–10—of the control lot. However, to check further the effect of CO_2, the No. 5 and the No. 6 of the heated plants were transferred on March 10, 1936 to the dry-ice lot. At this time there was no apparent sign of bud activities on these plants.

In general a great majority of the plants looked healthy before the treatments were made. Although some of them had newly developed flushes, on the whole, the buds were good. The total number of twigs per tree in the dry-ice lot ranged from 11 to 38, and these twigs were from 4 to 337 days old. The plants heated with an electric current had twigs ranging from 5 to 28 and were from 29 to 337 days old, and the control plants from 10 to 43 twigs each and 27 to 337 days old.

During the experiment, the plants were watered regularly to keep the soil in every pail uniformly moist throughout. The temperatures on each lot were recorded hourly each day by hanging various thermometers on the branches of the individual plants. The amount of CO_2 added to the plants was de-

termined daily by the so-called gasometric method. In addition to these, weather observations were taken daily while the experiment was going on.

The CO_2 gas was applied to the plants by exposing daily about a kilo of dry-ice.[1] This block of dry-ice was wrapped with perforated Manila paper and suspended on a pole erected at the middle and a little higher than the plants in the chamber. The chamber was made of abacá cloth built around the plants so as to keep the CO_2 sufficiently long with the plants. A small tin shed was set up at the top of the pole in order to protect the dry-ice from rains and excessive heat. With this device, the block of dry-ice gradually and slowly melted thus emitting fumes of CO_2 gas among the leaves of the treated plants. Similarly, an abaca cloth chamber was also constructed around the heated plants. But to conserve the heat as much as possible this chamber was later on reinforced with cellophane papers.

The determination of CO_2 applied daily by gasometric method as formulated by the Association of Official Agricultural Chemists(1) has been followed by Mr. Juan N. Samson of the Chemistry Section, as follows:

Reagents.—For displacement solution, 100 grams of NaCl was dissolved in 350 cc. of H_2O. About one gram of $NaHCO_3$ and 2 cc. of methyl orange indicator and a sufficient amount of H_2SO_4 (1+5) to make just acidic were added. The solution was decidedly pink in color and was stirred until all CO_2 was removed. And for the absorption of CO_2, about 50 grams of NaOH was dissolved for every 150 cc. of H_2O.

Apparatus.—The apparatus used in the sampling and in the analysis of CO_2 is shown in Fig. 1. It consists first of glass bottle (A) of about 10 liters capacity containing displacement solution which was connected to a 3-liter bottle (B) by means of a glass and rubber tubings. This 3-liter bottle was provided with bent glass tubings of 0.6 cm. in diameter. This bottle was strictly air-tight. It is this part of the apparatus that was used for sampling, the details of which will be discussed under sampling. A 100 cc. graduated gas-measuring tube with two stop-cocks, one on each end, was connected at its lower end with a leveling bulb (E) containing displacement solution, and at its upper end was connected to the 3-

[1] The dry-ice was obtained free from the San Miguel Brewery, Manila through the courtesy of Dr. F. T. Adriano.

liter glass jar and to the absorption gas pipette (D) containing NaOH solutions.

Sampling.—In sampling the CO_2 gas, the 3-liter bottle outfit described above was first filled with the displacement solution from a stock bottle. Then the outfit was taken to the place of the experiment where the gas was to be collected. At the end of the glass tubing (a), while collecting the gas, another

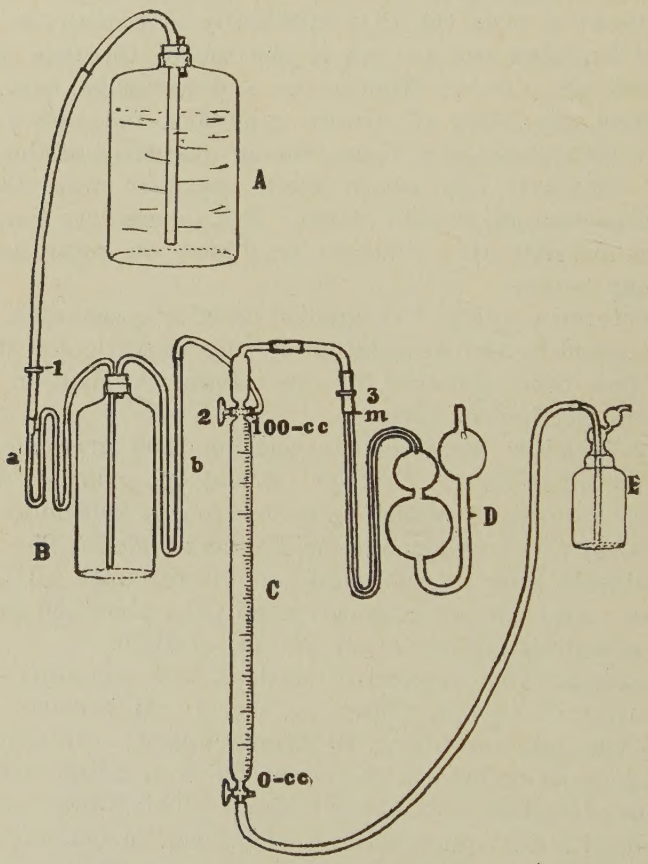

FIG. 1. Apparatus used in the sampling and in the analysis of CO_2 around the plants.

piece of glass tubing, about $1\frac{1}{2}$ meters long and 0.9 centimeter in diameter was temporarily connected by means of rubber tubing. All the connections were made airtight to avoid any leak. In collecting the gas, the glass tubing which served as a sucking or inlet tube was inserted into the chamber of the plants to which CO_2 gas was being applied. As soon

as this was done the bottle containing the displacement solution was inverted and the solution was drained off slowly through (b) which was extended also by means of a rubber and glass tubings to reach a receptacle bottle temporarily placed on the ground to receive the displacement solution. In draining this solution the container was placed on a convenient stool and held firmly by means of an iron stand. This 3-liter bottle (B) as mentioned above served as an aspirator to receive the gas sample, which filled the vacuum created by draining the displacement solution from the bottle. The collection of gas from the chamber was done uniformly by moving the sucking or

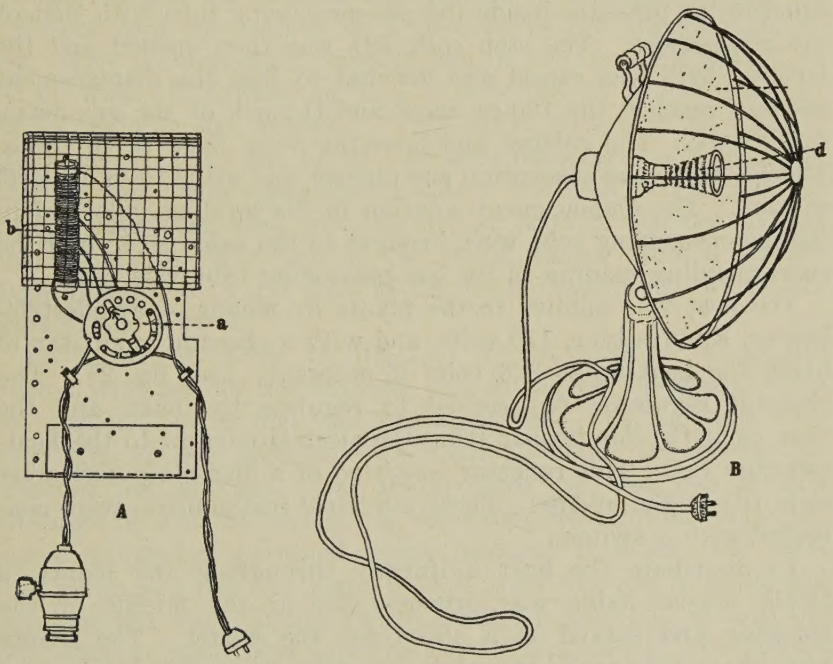

FIG. 2. Apparatus used for supplying heat to the plants.

inlet tube to the different parts of the chamber. When the displacement solution had been drained, the bottle containing the gas sample was brought to the laboratory and connected to the rest of the apparatus as in fig. 1, and the determination of the CO_2 gas was made accordingly.

Determination.—The graduated gas-measuring tube was filled with the displacement solution to the pinchcock which is to the 100-cc mark, by raising the leveling bulb. The displacement solution was allowed to flow from glass jar (A) to the bottle (B) containing the sample by opening pinch cock (1)

until the air in glass tubing (b) was expelled. The end of (b) was then connected to the pinch cock (2) of the gas-measuring tube by means of a rubber tubing. The leveling bulb was then lowered until the displacement solution in the gas-measuring tube reached the zero mark. The pinch cock was then closed and the rubber tubing was disconnected. In lowering the leveling bulb, vacuum was created, thus causing the suction of the gas sample into the gas-measuring tube. The level of the displacement solution in the gas-measuring tube and in the leveling bulb were brought to the same level and the pinch cock (2) was opened for about 5 seconds to equalize the pressure inside the gas-measuring tube with that of the atmosphere. The stop cock (2) was then opened and the leveling bulb was raised and lowered so that the displacement solution reached the 100-cc mark and O-mark of the gas-measuring tube. The raising and lowering were done three times. The NaOH in the absorption gas pipette was made to be in level at (m). The displacement solution in the leveling bulb and in the gas-measuring tube were brought to the same level, and the corresponding reading in the gas-measuring tube was read.

The heat was applied to the plants by means of an electric-heater, Empire type, 110 volts, and with a rheostat regulator to bring the heat up to 220 volts if necessary (see fig. 2). The rheostat regulator (a) served to regulate the heat, and the wire coils (b) for transmitting the electric current to the heat-reflector (c). This reflector consisted of a disc plate with wire coils (d) at the middle. These electrical instruments were connected with a switch.

To distribute the heat uniformly throughout the plants, a small, low-set table was provided for at the middle of the chamber and served as a stand for the heater. The plants were arranged around the heater in order to receive the heat as much as possible. Besides, the heat-reflector was changed toward the other directions from time to time. To protect the apparatus from rains, a movable galvanized iron roofing was provided for. However, this roofing was seldom used because of the prevailing good weather during the course of the experiment.

RESULTS

The results of the experiment are shown in the following tables.

Of the 7 plants treated with dry-ice 6 responded which represented an average of 85.71 per cent. While of the heated plants only 20 per cent had produced new flushes, which result

was even lower than that of the control—28.57 per cent. Taking the trees as a whole, and with the exception of Tree No. 6 which was transferred from the heated chamber to this lot, they all produced new buds ranging from 13.33 to 100 per cent, or with an average of 68.41 per cent against 20 and 27.3 per cent of the heated plants and the control, respectively. The development of new buds took place in 23 to 70 days, or a total of about 157 to 401 hours application of carbon dioxide.

The air was enriched for about 5 to 6 hours daily with carbon dioxide ranging from 3.59 to 3.63 per cent by volume and applied mostly in the morning. The usual amount of carbon dioxide in the air around the premises varied from 0.02 to 0.03 per cent by volume, or 2 to 3 parts per 10,000 parts of air. The average daily temperature in the chamber was 31.08 °C or with an increase of 1.17°C over the air temperature of 29.9°C outside the chamber. This slight difference in temperature was perhaps due to the enclosure made around the plants. During the dry-ice application there were 48 bright and 22 cloudy days compared with 50 and 22 days of the heated and control plants. The age of the twigs varied from 4 to 337 days against 29 to 337 days of the heated plants and 27 to 337 days of the control.

As shown on Table II, the bud development of the plants heated with an electric current was so meager compared with the carbon dioxide and the control plants. For instance, only Tree No. 17 had produced new buds in about 209 hours distributed for 28 days. But at the time the tree was treated although it has 23 twigs, its condition was rather poor because its trunk sustained some physical injuries. In 1933, this plant had but one main branch with five newly developed twigs at the end. Under this condition it was but natural for this plant to send new growths for its sustenance irrespective of the treatment given to it. The other trees in spite of their normal growths and maturity of their twigs, which the minimum age averaged to 119 days and the oldest 310.8 days compared with 81.5 and 315.4 days of the plants subjected with carbon dioxide, did not produce any even after subjecting them with a temperature ranging from 3.1 to 5.7°C for about 6 hours daily, or an average of 4.14°C for 498.7 hours in 72 days. However, one of the trees—No. 5—when treated with carbon dioxide for about 157 hours in 27 days, 100 per cent of its twigs produced new buds. This indicates clearly the influence of carbon dioxide on the development of mango buds.

TABLE I.—*Showing the effect of CO_2 on carabao mango buds*

Tree No.	Twig		Weather		Average daily temperature			Treatment		Bud development		
	No. per tree	Approximate age in days	No. of bright days	No. of cloudy days	Air (°C)	In the chamber (°C)	Difference (°C)	No. of hours	Pct. by volume of CO_2 per day	No. of days	No. of buds	Per cent
1	38	4–302	46	21	30.2	31.5	1.3	401.30	3.62	67	36	94.07
5 [a]	11	238–344	19	8	30.3	31.6	1.3	157.05	3.59	27	11	100.00
6 [a]	28	139–337	23	9	29.9	31.1	1.2	186.50	3.61	32		
11	15	137–337	48	22	29.2	30.5	1.3	436.60	3.63	70	2	13.33
12	13	16–337	29–39	9–11	29.1	30.6	1.5	302.20	3.62	38–50	12	92.30
15	13	32–337	17	10	30.5	31.2	0.7	193.00	3.62	27	13	100.00
19	24	5–214	15–18	8–10	30.2	31.1	0.9	193.00	3.62	23–28	19	79.16
Total	142	571–2208	210	91	209.4	217.6	8.2	1,869.65	25.31	301	93	478.86
Average	20.2	81.5–315.4	30	13	29.9	31.08	1.17	267.09	3.62	43	13.3	68.41

[a] These plants were previously treated with electric current.

TABLE II.—*Showing the effect of heat on the development of carabao mango buds*

Tree No.	Twig		Weather		Average daily temperature			Treatment in Hours	Bud development		
	No. per tree	Approximate age in days	No. of bright days	No. of cloudy days	Air (°C)	In the chamber (°C)	Difference (°C)		No. of days	No. of buds	Per cent
5	11	238–344	27	13	29.6	33.3	3.7	266.25	40	-------	-------
6	28	139–337	27	13	29.6	33.3	3.7	266.25	40	-------	-------
13	5	91–238	50	22	30.3	36.0	5.7	498.70	72	-------	-------
14	15	98–298	50	22	30.0	34.5	4.5	498.70	72	-------	-------
17 [a]	23	29–337	18	10	29.7	32.8	3.1	209.35	28	23	100
Total	82	595–1,554	172	80	149.2	169.9	20.7	1,739.25	252	23	100
Average	16.4	119–310.8	34.4	16	29.84	33.98	4.14	347.85	50.4	4.6	20

[a] The condition of the tree was rather poor.

TABLE III.—*Showing the behavior of the control plants*

Tree No.	Twig		Weather		Bud development			
	No. per tree	Approximate age in days	No. of bright days	No. of cloudy days	Air temperature (°C)	No. of days	No. of buds	Per cent
2	25	49–292	50	22	30.2	72	--------	--------
3	43	27–49	50	22	30.2	72	--------	--------
4	11	121–170	28–36	8–11	29.5	36–47	10	90.9
7	12	121–292	47	22	29.5	69	12	100.00
8	10	34–232	50	22	30.2	72	--------	--------
9	23	27–292	50	22	30.2	72	--------	--------
10	23	27–337	50	22	30.2	72	--------	--------
Total	147	406–1,664	333	143.0	210.0	476	22	190.9
Average	21	58–237.7	47.5	20.4	30.0	68	3.1	27.3

Of the 7 control plants, two sent new flushes but these trees were also in a very poor condition together with Tree No. 8 which remained dormant throughout the experiment. In 1933, Tree No. 7 produced only three shoots from its three weakened branches, while Tree No. 4 produced 5 new shoots in the same year from its two main but very defective branches. The air temperature around the plants averaged 30.0°C.

SUMMARY

1. This experiment gives the comparative effect of carbon dioxide and heat on the development of the Carabao mango buds whereby the dry-ice was the source of the carbon dioxide and electric current for the heat.

2. The effect of the heat was not so striking as the carbon dioxide, which result was even lower than the control plants as regards the development of the buds.

3. The use of carbon dioxide showed the greatest bud development.

LITERATURE

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ILLUSTRATIONS

TEXT FIGURES

PROGRESS REPORT ON STRAWBERRY TESTS AT BAGUIO, MOUNTAIN PROVINCE

By MARIANO E. GUTIERREZ

Of the Baguio Plant Industry Experiment Station

INTRODUCTION

Strawberry, *Fragaria chiloensis,* is one of those plants successfully introduced, which has become permanent in the Philippines. Being distinctly a temperature country plant, it thrives best in our cool highlands, like Baguio, Trinidad Valley, Mountain Province, and other high regions, above 2,000 feet elevation, where the climate is cool.

In general, in this country of adoption, it has partly lost some of its important and distinguishing characteristics at home, such as, ease of growth and culture, even growing in a wild state, luxuriance, heavy runner production, size of berries, shipping quality, and sweetness. The last two qualities, however, persist in a few of the varieties introduced.

Due to the above limitations, we cannot translate here in their entirety the successful cultural practices given to it at home. For a permanent foothold of strawberry in this country, it is eminently desirable to know its newly acquired habits and requirements in the new country. For example, due to abundant runner production, strawberry at home can stay productive for more than a year in the same ground. With partly losing this character in the Philippines, it has to be planted anew every year, otherwise no marketable berries can be harvested in the second year. Likewise, the matted row system of culture, taking advantage of the runner production, cannot be followed in this country.(1, 2).

Producing strawberries successfully here presupposes a series of long and continued trials such as introduction and adaptability tests of all available good varieties and novelties from different countries, variety tests, seasonal planting, cultural methods, spacings, planting material tests, fertilization, breeding, etc., so that a combination of the best findings in these experiments may evolve a good system of profitable culture

in the new country of adoption. Often with a new crop our farm practices are empirical, because of newness or borrowed unchanged from the practices abroad. What is said of its culture applies also to the absolute reliance on varieties found best in certain countries and their introduction, expecting that these varieties will duplicate their performance here.

Strawberry, praised highly by Doctor Boteler(3) with the oft-quoted statement: "Doubtless God could make a better berry, but doubtless God never did," ranks foremost as a table delicacy among the vegetables and fruits grown but of imported origin in Baguio. With Americans and Europeans, strawberries are eaten as a matter of course; with us Filipinos, strawberries like cauliflower and avocados, come under the class of new foods, requiring cultivated taste. Being a good food, our compatriots not only relish it now in its fresh or preserved state but is the gift (*regalo* or *pasalubong*) *par excellence* to loved ones, or friends. Flowers being common everywhere it is more forceful to say it with Baguio strawberries. So it is, that during the summer in Baguio, production is insufficient to meet the ever-growing demand of this attractive, fragrant, and luscious berry. Hectarage may be doubled, nay, trebled, and yet the supply will be inadequate. The proper culture of strawberries, therefore, is fraught with great possibilities.

Strawberry is the main crop of the Baguio Plant Industry Experiment Station and has acquired an enviable reputation for cleanliness, sweetness, and quality. It is rated by Americans and Europeans as the best the Baguio trade could offer. This may be attributed to the fact that the accumulated knowledge acquired from our tests are put into practice in our field culture. Coöperators, like Mr. Jesus Cacho in his Paraiso Plantation at Yagyagan, Sablan, who follow our method of culture and plant the specific varieties recommended to them, can produce berries ranking next to the station's.

The following pages report the progress mostly of first year results of strawberry tests, and recapitulates the three-year fertilizer tests in connection with a new fertilizer experiment. They are presented here with the view of recording the facts thus far found, which may need further verification or corroboration in future repeated tests in order to arrive at more conclusive truths and to serve as a guide in strawberry culture.

In order to get the gist of these findings, after the exposition of facts borne by these various subjects treated, they will be col-

lected and presented at the end of this report in a succinct summary. In the light of our present knowledge gained thus far from these experiments, they are recommended in the interim to commercial strawberry growers, whose farms have similar conditions as the Baguio Plant Industry Experiment Station.

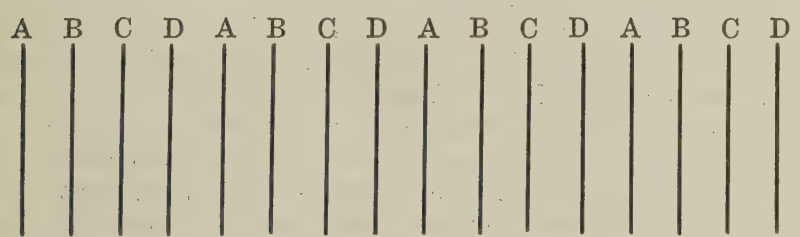
GENERAL STATEMENT OF SIMILAR OPERATIONS COMMON WITH THE TESTS UNDER REVIEW

In order to avoid useless repetitions of the same facts in every test, the following general statement of operations, which were identically the same in different tests are mentioned. Any variation from these will be stated for each test.

Time and place.—With the exception of two earlier tests, these tests were conducted in the strawberry season of 1936–37, all at the Baguio Plant Industry Experiment Station, Baguio, Philippines.

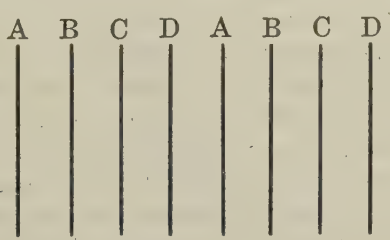
Beds and arrangement of replications.—Our standard beds were 1.2 m. wide, permitting three rows of strawberry plants set in triangles, spaced 30 cm. between plants. When these beds ran throughout the length of the field, the replicated beds or plots were arranged as follows:

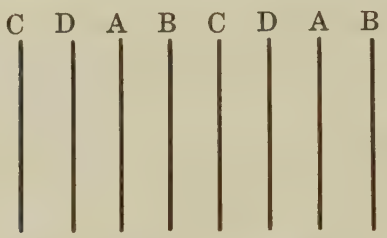
Arrangement I



When the beds were short, permitting two columns of beds in the field, the replications were arranged as follows:

Arrangement II





Land conditions.—For each experiment, efforts were made to use land with fairly uniform conditions as to fertility, topography, exposure, soil, etc.

Planting materials used and treatments.—With the exception of certain tests, the planting materials used were the old strawberry clumps, washed, conveniently divided into sets, cleaned of dry and old leaves, branches and old roots cut off. As our fields were previously infested by strawberry thrips, the cleaned plants were soaked for 5 minutes in a solution of Imazu (70 grams) and soft soap (80 grams) dissolved in 20 liters of water.

Mulching material.—Unless otherwise stated, the mulching material used was a mixture of pine needles and the cut grasses growing below the pine trees. The mulch was applied after the second application of fertilizers.

Rate and method of fertilizer application.—The fertilizer was applied at the rate of one (1) ton per hectare. Fractional application was resorted to: one-half of the amount at planting time, placed in each hole and mixed with earth before setting the plants or shortly thereafter by scattering the fertilizer close to the plants and the earth stirred with the hand cultivator. The second half of the fertilizer was applied when the plants were about to bloom and was immediately followed by the mulch.

The area per bed.—In all these tests, the corresponding 40 cm. wide path alongside each bed was included in the area of every bed, in order to include these blank or dead spaces in the field and get the correct yield, as the paths are parts of the field planted and necessary for operations.

Frequency of picking berries and manner of recording yields.—Picking of berries was done thrice a week: Mondays, Wednesdays, and Saturdays. The yield per plot was separately picked and placed in paper bags, properly labelled to correspond to the plot number. These were weighed separately and then recorded in the Strawberry Book at the office. Picking was continued from 3 to 5 months, or until the yield per plot was so low as

to justify separate weighing. The total yield for each replicated plot or bed are given in the different tables of results.

I. ADAPTABILITY TESTS OF STRAWBERRY VARIETIES

Ever since this station started planting strawberry, it has continuously carried on adaptability tests. Some 31 introductions, consisting of 26 varieties, have been tested. A few of them gave very successful results and now supply planting materials for our cultures. Others are gradually being adapted and in process of multiplication. Many of the varieties are indifferent and a few of these are affected by disease and are to be discarded. Other varieties could not stand the conditions and therefore gradually died out, without even a living representative to show their existence.

For a better understanding of the extent of these introductions and the kinds of varieties tried, the following list was obtained from our records, showing P. I. numbers, variety, origin, and

TABLE 1.—*Showing a list of strawberry varieties from different sources introduced into this station for the decade 1926–1936*

P. I. No.	Variety name	Origin	Date of introduction
9,773	Wilson	Trinidad Valley	Dec. 16, 1926.
9,552	*Fragaria* sp	U. S. Dept. of Agriculture	Nov. 4, 1927.
9,789	Ecuador	United States	Mar. 10, 1928.
10,352	F. *chiloensis*	Poona, India	Dec. 19, 1930.
	Hood River	Trinidad Valley	Jan. 5, 1931.
10,501	Large Red Alpine	Reading, England	Aug. 25, 1931.
10,502	Royal Sovereign	Reading, England	Aug. 25, 1931.
10,746	Big Joe	Geneva, O. U. S. A.	Feb. 18, 1931.
	Missionary	United States	Aug. 4, 1931.
	Klondyke	Florida, U. S. A.	Aug. 4, 1931.
	Blakemore	Florida, U. S. A.	Jan. 26, 1932.
	Howard 17	United States	Jan. 26, 1932.
	Missionary	United States	Feb. 27, 1932.
12,246	Southland	Michigan, U. S. A.	December 21, 1933.
12,247	Fairfax	Michigan, U. S. A.	December 21, 1933.
12,248	Dorsett	Michigan, U. S. A.	December 21, 1933.
12,249	Bellmar	Michigan, U. S. A.	December 21, 1933.
12,250	Super Giant	Michigan, U. S. A.	December 21, 1933.
12,251	Mastodon	Michigan, U. S. A.	December 21, 1933.
13,252	Big Joe	Michigan, U. S. A.	December 21, 1933.
12,253	Chesapeake	Michigan, U. S. A.	December 21, 1933.
	Aroma	Lipa, origin U. S. A.	April 6, 1936.
	Fairfax	Lipa, origin U. S. A.	April 6, 1936.
	Narcissa	Lipa, origin U. S. A.	April 6, 1936.
	Clermont	Lipa, origin U. S. A.	April 6, 1936.
	Camden	Lipa, origin U. S. A.	April 6, 1936.
	Dorsett	Lipa, origin U. S. A.	April 6, 1936.
	Mastodon	Lipa, origin U. S. A.	April 6, 1936.
	Pearl	Lipa, origin U. S. A.	April 6, 1936.
	California, no variety name	Baguio, Mountain Province	September 7, 1936.
	New Zealand	Baguio, Mountain Province	September 7, 1936.

approximate date of introduction. It can be seen that a variety may have been introduced twice.

Of the early introductions, Hood River and Wilson varieties were found to be the best adapted to our conditions and at present constitute our large experimental and commercial cultures.(4) Hood River has large berries, obcordate in shape, subacid, and soft of flesh. It does not have a good shipping quality. The plants are of fair height, and the leaves are large and light green. It has lost its runner production under our conditions. The greater part of our cultures is of this variety.

The Wilson has elongate and tapering berries, and is slightly sweeter than the Hood River. It has slightly better shipping quality than the former. Between the two, there is not much difference in vegetative appearance.

Missionary comes third as the successful introductions. The vegetative growth is not as dense as the first two and of slightly lighter color. It has the unique distinction of not losing the home characteristic of producing profuse runners. The principal objection to its berries is their sour taste, but their flesh is firm, an indication of good shipping quality. Superintendent José de Leon of Lipa Coffee–Citrus Experiment Station stated to the writer in February, 1937 that this variety is adapted to the Lipa altitude of 1,000 feet.

Klondyke is gradually being adapted; the berries are objectionable for being also sour. It is a shy bearer.

Dorsett, Big Joe, Mastodon, Bellmar, and Fairfax show fair adaptability. Dorsett and Fairfax were bred by the United States Department of Agriculture. Both have good shipping quality, but Fairfax turns out sweeter berries than Dorsett.

Chesapeake, Blakemore, and Howard 17 show poor adaptability, especially the last two. Blakemore is affected with chlorosis, which may be the symptom of mosaic.

Ecuador is poor, seriously affected with very pronounced leaf spots, and should be discarded.

Of the introductions made in 1936, Narcissa is considered the best. This variety has heart-shaped dark red berries, very sweet, with firm red flesh and of good shipping quality. It is the largest plant among the new introductions. Observations show that after the fruiting season, Narcissa stands out prominently as one with luxuriant foliage and show little signs of being stunted as the other introductions grown side by side with it. It is also the least affected by diseases and pests. Nar-

cissa shows great promise and may yet surpass either the Hood River or the Wilson.

Clermont and Aroma, next to Narcissa, in the order named, are well adapted. Canden is fairly well adapted.

The second introduction of Fairfax and Dorsett show fair adaptability.

Mastodon and Pearl are poor.

The California and New Zealand varieties show good adaptability, although the berries of both are small. The New Zealand has sweeter berries than the California variety.

In general, the recent introductions that are doing well have darker and smaller leaves than the Hood River. They are low and compact.

II. ROOTED VERSUS UNROOTED STRAWBERRY PLANTING MATERIALS

Object.—The object of these tests was to compare on a fairly large scale the behavior of rooted plants, previously grown in the nursery, with ordinary plants taken from the old strawberry fields. Which of the two planting materials yields earlier and more berries?

Materials and methods.—Hood River strawberry ordinary planting materials were planted in seedbeds, spaced 15 cm. apart each way, from May 29 to June 6, 1936. These plants were planted in the same manner as our ordinary field planting, except in the very close spacings.

After two and one-half months in the nursery, the plants were carefully taken out with all the young roots and part of the earth adhering and were set in one-half of our field of 470 sq. m. or 235 sq. m., known as Plot A, consisting of 7 beds. The second half of the field, Plot B, also of 7 beds, was simultaneously planted with plants from the old fields, cleaned, conveniently divided, and disinfected. Before planting these plots, compost at the rate of one petroleum canful for every 1.2 sq. m. was applied to all the 14 beds. Subsequent treatments of these two plots, such as weeding, spraying, mulching, fertilizing with ammophos plus sulphate of potash, and watering were uniform.

Observations.—Plot A with the nursery plants showed better vegetative development than those of Plot B with the ordinary planting material. Plot A also showed earlier tendency in blooming and bearing. On November 23, 1936, the first harvest of marketable berries was made from Plot A, while from Plot

B, the first harvest was made on November 30, one week later. Picking of berries in both plots ended on April 17, 1937, or a period of nearly 5 months. In every harvest, the yield of Plot A was consistently greater than the amount of berries picked from Plot B. As it would occupy too much space to present the whole period comprehended in the harvest, the above fact could be easily seen by reproducing part of this harvesting period, from December 16, 1936 to January 30, 1937, or a period of 1½ months only.

TABLE 2.—*Showing the amount of berries in kilos picked simultaneously at regular intervals from each plot, and the difference always in favor of Plot A.*

Date of harvest	Yield in kilos of berries		Difference in favor of Plot A
	Plot A	Plot B	
			kilos
December 16, 1936	1.60	0.36	1.24
December 19, 1936	3.00	0.86	2.14
December 21, 1936	2.40	0.56	1.84
December 23, 1936	3.00	1.20	1.80
December 26, 1936	4.40	1.60	2.80
December 28, 1936	3.00	0.78	2.22
December 30, 1936	3.20	1.40	1.80
January 2, 1937	4.60	2.20	2.40
January 4, 1937	4.20	1.60	2.60
January 6, 1930	4.00	1.60	2.40
January 9, 1937	5.40	2.20	3.20
January 11, 1937	4.00	1.80	2.20
January 13, 1937	2.80	1.40	1.40
January 16, 1937	6.00	2.80	3.20
January 18, 1937	2.60	1.00	1.60
January 20, 1937	3.80	1.20	2.60
January 23, 1937	3.80	2.20	1.60
January 25, 1937	2.60	1.40	1.20
January 27, 1937	2.00	1.60	0.40
January 30, 1937	3.00	2.00	1.00
etc., etc.			

For the entire harvesting period, the total yield from Plot A was 147.30 kilos or a calculated yield of 6268.1 kilos per hectare, while Plot B yielded 70.42 kilos or a calculated yield of only 2996.6 kilos per hectare.

Summary.—The rooted strawberry planting material consistently produced greater amount of berries at every picking day and yielded marketable berries earlier than the unrooted planting material, thus prolonging the period of harvest. The nursery planting material more than doubled the total yield obtained from the plot with the ordinary planting material.

These tests may be repeated next season, but will be included in the planting materials tests, the first season results of which follow.

III. TESTS OF DIFFERENT STRAWBERRY PLANTING MATERIALS

Object.—To test the productive efficiency of different planting materials. Which is the most productive, plants, runners, or seedlings?

Materials and methods.—The fairly uniform field chosen for these tests was divided into 12 beds with an area of 16 sq. m. each.

The different variables were:

A. Plants from old clumps (clons).
B. Runners, rooted plantlets from runners.
C. Seedling plants, unselected grown one season ahead from seeds.

Only the variety Wilson supplied all the above planting materials.

The plots of the different variables were replicated four times and the beds were laid out as per Arrangement 11.

With the exception of the varying planting materials, the beds were given uniform treatments, as to the amount and kind of fertilizer, being ammophos plus sulphate of potash, cultivation, spraying, watering, etc.

Planting was carried out during the last week of August, 1936. Mulching was completed in October of the same year.

Observations.—Of the different planting materials, the runners showed the best vegetative growth and were the tallest, followed by the seedlings. The seedlings, however, were not uniform, due to the fact that they did not come from a pure seedling strain for lack of the material. The plants showed the poorest vegetative development. The seedlings showed the earliest tendency to bear berries, which fact was noticed on October 8, 1936. There were more berries noted with the seedlings than any of the two other planting materials, although the size of the berries was very variable. On the other hand, the berries from the plants and runners were more uniform in size.

Results.—Picking of the berries under these tests was started on November 28, 1936 and ended on March 24, 1937,—a period of about 4 months. The results may be seen in the following table.

TABLE 3.—*Showing the yields of the different replicated beds, the average yields of the three variables, and the calculated yield per hectare of the plants, runners, and seedlings.*

Plants		Runners		Seedlings	
Plot No.	Yield in kilos	Plot No.	Yield in kilos	Plot No.	Yield in kilos
1–A	1.67	1–B	3.94	3–C	4.78
4–A	4.78	5–B	4.25	6–C	4.16
7–A	5.35	8–B	5.24	9–C	7.04
10–A	7.20	11–B	4.82	12–C	7.24
Total yield	19.00		18.25		23.22
Average per plot	4.75±0.287		4.56±0.576		5.80±0.287
Calculated per hectare	2,968.7		2,850.0		3,625.0

Interpretation of results.—In accordance with the above results, the seedling plants outyielded both the runners and the plants, the latter coming second. With the runners the luxuriant vegetative development was made at the expense of berry production. The difference, however, between the average yields of the plants and the runners per plot is very slight and it may be considered insignificant. This slight difference between the two is to be expected, as for practical purposes, the materials are of the same character, being clons or asexual parts of the same plants. The performance of the unselected seedlings used in these tests is of far reaching consequence and is indicated as a method for improving both the adapted and the recalcitrant varieties. In this connection, it should be borne in mind that practically all of our existing varieties were imported as plants, highly bred and adapted from whence they came. As a general practice here the increased propagation of the plants was made from plants, rarely from runners for want of same, and never from seeds. So that in our yearly repeated plantings, no change has been made of the planting materials and consequently of the adaptability or hereditary quality of the plants to the new set of conditions.

Were the seedlings used of pure strain, the yield registered would be still greater.

As strawberry varieties may be cross-pollinated by agency of insects or by the wind, it can be granted as one possible reason for this heavier yield, that some of the seedlings were first generation hybrids, exhibiting heterosis; although the fact of hybridity may not be general as the seeds were gathered from separate cultures of the varieties.

Summary.—From the above initial results, it may be tentatively concluded that seedlings are better yielding planting materials than either the plants or the runners, both being clons of the original imported plants. Were there any productive pure strain of Wilson available for these tests to supplant the mixed population used, the yield would be still greater.

IV. STRAWBERRY SEEDLING AND SELECTION TESTS

Object.—The objects of these tests are to produce better adapted strains to Baguio conditions than their parents and to isolate productive or other strains with desirable qualities.

Materials and methods.—During the strawberry season of 1934–35, seeds of the following varieties were collected separately namely, P. I. 9773 Wilson, P. I. Missionary, P. I. 10,746 Big Joe, P. I. 12,249 Bellmar, P. I. 12,247 Fairfax, and P. I. 12,251 Mastodon.

Seeds were sown in seedflats on August 22, 1935. In November of the same year, the seedlings were pricked in partially shaded beds.

During February 12 to March 5, 1936, the different varieties were transplanted in separate beds for observation and propagation. From these plantings selections of the best looking plants were made. Our 101 selected plants were as follows:

Wilson	25 strains	(Wi–1–25)
Missionary	25 strains	(Mis 1–25)
Mastodon	25 strains	(Mdn 1–25)
Bellmar	11 strains	(Bel 1–11)
Big Joe	10 strains	(BJ 1–10)
Fairfax	5 strains	(Ff 1–5)

Beds, 1.5 m. wide, were prepared for planting separately these strains, in order to give sufficient room for the strains to be planted in transverse order in the beds. Planting was made on August 7, 1936. As we were depending on the available planting material from single seedling mother plants, with varying number of suckers and runners, the planting materials from each mother plant naturally varied from a few to 54, the last indicating profuse runners. These were planted for observation and multiplication, in order to select further the very best, and later to be planted in test rows for comparison of possibilities.

Periodically these strain cultures were examined and studied. Separate record was made of each strain noting the outstanding characters. Sampling of the berries was made periodically in order to determine their shipping and eating qualities, especial-

ly with regard to firmness of flesh and the taste whether sour, subacid, or sweet.

The different strains of each variety manifested wide variability in the different characters. These variations were seen in the vigor and luxuriance of the plants, height, runner propensity, size of leaves, shape and size of berries, softness and firmness of flesh of the ripe berries, and the eating quality. Some of the strains of certain varieties exhibited different degrees of acidity from very sour to sweet. These wide variations were very favorable indeed for selection work. In general, the plants belonging to each strain were very uniform in their characters.

After a series of thorough observations, the following strains were finally picked out and marked for plant-to-the-row tests for the next season:

P. I. 9773 Wilson

Strain No.	Selected for
Wi–3	Robustness and large elongate berries.
Wi–5	Robustness and earliness.
Wi–11	Robustness.
Wi–14	Sweetness.
Wi–18	Size and sweetness; productiveness.
Wi–19	Productiveness.
Wi–22	Robustness and productiveness.

P. I. 9773 Missionary

Mis–2	Robustness.
Mis–7	Sweetness.
Mis–8	Sweetness.
Mis–9	Runner production.
Mis–13	Robustness and size of berries.
Mis–17	Sweetness, size of berries, and shipping quality.
Mis–19	Robustness and sweetness.
Mis–23	Sweetness and size of berries.

P. I. 12,251 Mastodon

Mdn–4	Productiveness.
Mdn–6	Robustness.
Mdn–8	Shipping quality.
Mdn–13	Productiveness.
Mdn–14	Robustness.
Mdn–15	Size of berries and shipping quality.
Mdn–17	Sweetness and size of berries.

P. I. 12,249 Bellmar

Bel–1	Size of berries.
Bel–3	Productiveness, size of berries, and shipping quality.
Bel–8	Elongate berries.
Bel–11	Uniformity and robustness.

P. I. 10,746 Big Joe

BJ–8..... Productiveness.
BJ–10..... Size of berries.

P. I. 12,247 Fairfax

Ff–1..... Adaptability.
Ff–2..... Sweetness and shipping quality.
Ff–3..... Robustness.

It is quite premature to state definite facts about these seedling selections. It is desirable to plant them in test rows with the original asexually propagated plants as checks.

Since all our fields of strawberry were the result of continuous asexual propagation from plants highly adapted and bred from the countries of origin, we have not made any change in their reaction to the new environment. Since a plant is both a product of heredity and environment,(5) it would seem that sexual propagation by the use of seeds will make a change in the resulting plants. In our tests just described, comparing seedlings with asexual materials, we found that the seedlings were more productive than the clons, which proves our contention. We may grant that some of the seedling plants are first generation hybrids, due to occasional cross fertilization in the field and exhibit heterosis or hybrid vigor. For continuous asexual propagation of these hybrid seedings, they will remain always first generation hybrids, exhibiting the desirable hybrid vigor, which will be for the better.

It is believed that with sexual propagation, the new environment may have been impressed in the seeds, or the adaptability to the new set of conditions could be obtained more readily by the use of seedling material than with the asexually propagated material for several years. The great variability exhibited by these seedlings, the recovery of certain characters or the attaining of new ones,—all prove that improvement in several characters may be obtained by the rigid selection of the best seedlings of these varieties.

For improving our different varieties, exhibiting poor or fair adaptability to our conditions, this method of propagation opens untold possibilities. We may mention one fact noted in our seeding selection work. The variety Missionary has consistently produced sour berries for seven years here. This variety is remarkable in retaining the character of runner production and the fact that it is the only variety, thus far found, which does well in much lower altitude than Baguio, at the

Lipa Coffee–Citrus Experiment Station, 1,000 feet above sea level. Two seedling strains, Mis–7 and Mis–8, produce sweet berries, which is a drastic departure from the sour taste of the berries from asexually propagated material.

V. PINE NEEDLE COMPOST VERSUS ORDINARY COMPOST FOR STRAWBERRY

When the writer took charge of the station, two years ago, pine needles were used exclusively for mulching strawberries. This is because it is the most abundant local material for the purpose and the only expense involved is the gathering of same in our pine forest. It had been also the invariable practice that this partly composted pine needles on the beds were buried under in the preparation of the field for another crop. A part of a field similarly managed and then planted to strawberry a second time gave no yield of marketable berries. Subsequent treatments of the beds with different kinds of fertilizers, lime, ashes, etc., gave no improvement on yield, except foliage appearance. It was then suspected that the decomposed pine needle mulch of the previous strawberry crop, incorporated into the soil, may be inimical to the normal production of berries. To confirm or disprove this suspicion, it was necessary to subject this to an experimental test.

Object.—The object of these tests was to determine the effect of pine needle compost in comparison with ordinary compost and no compost application on the yield of berries.

Materials and methods.—A field, which was never planted to strawberry, and therefore free from pine needles, was selected for these tests. This field was previously planted to sweet potatoes, and just previous to these tests, with tomatoes. It was divided into 12 beds of an area of 40 sq. m. each.

The different variables or treatments were:

A. Pine needle compost, applied at the rate of one petroleum canful for 1.2 sq. m.

B. Ordinary compost (of grasses, animal manure and crop residues, mixed), at the same rate as A.

C. Check. No compost application.

The beds were replicated four times and were laid out as per Arrangement 1.

All the beds were fertilized with Station Mixture No. 2 (10 N–8 P_2O_5–6 K_2O) at the rate of one ton per hectare. The first half of the fertilizer was applied at planting time, while the second half was applied on August 5, 1936.

The variety used was the Hood River, which was planted on June 24, 1936.

On August 8 of the same year, the beds were uniformly mulched with dried reeds, instead of the usual pine needles. Reeds were used as the mulching material in order to forestall the effect, if any, of pine needle mulch.

Due to the initial infestation of small yellow spotted beetles on the leaves, all the beds were uniformly sprayed with 0.75 per cent of lead arsenate and soap solution (150 grams of lead arsenate and 50 grams of soap in 20 liters of water). The infestation was put under control.

Observations.—Ocular observation of the strawberry plants with the different treatments was periodically made. The beds with the ordinary compost application showed the best development, followed by the check beds. The beds with the pine needle compost application showed the poorest development. The appearance and size of berries of the compost (ordinary) and the check beds were normal; the berries with the pine needle compost were smaller and less in number.

Results.—Picking of berries was made at regular intervals, beginning on October 26, 1936 and terminating on January 30, 1937. The yields of the different replicated beds may be summarized in the following table.

TABLE 4.—*Showing the yields of berries in kilos of the different replicated beds of the three treatments, the average yield per bed of each variable, the calculated yield per hectare, the difference of yield against pine needle compost, and the value thereof.*

Pine needle compost		Ordinary compost		Check. No compost	
Plot No.	Yield in kilos	Plot No.	Yield in kilos	Plot No.	Yield in kilos
1–A	7.35	2–B	11.21	3–C	8.31
4–A	5.70	5–B	9.44	6–C	7.09
7–A	6.55	8–B	11.67	9–C	9.96
10–A	8.45	11–B	9.34	12–C	9.61
Total	28.05		41.66		34.97
Average per bed	7.012±0.438		10.415±0.289		8.742±0.289
Calculated yield per Hectare	1,753.0		2,603.7		2,185.5
Difference against pine needle compost			850.7		432.5
Value of difference at ₱0.30 per kilo			₱255.21		₱129.75

Interpretation of results.—Taking the calculated yield per hectare of the three treatments, as a basis for comparison, it can be readily seen that the pine needle compost yielded 432.5 kilos of berries below the check, and 850.7 kilos below the or-

dinary compost. The appreciable reduction of yield registered by the pine needle compost was very great, in spite of the fact that all the variables under comparison received the same amount of fertilizer, showing that the bad effect of pine needle compost for strawberry transcended the good effect of the fertilizer. When we value these differences, we find a loss of ₱129.75 per hectare for the use of pine needle compost in comparison with the check, and a greater loss of ₱255.21 in comparison with the use of ordinary compost. The difference between these two amounts must be definitely attributed to the complementary good effect of ordinary compost for strawberry in conjunction with the fertilizer.

Summary.—Pine needle compost for strawberry is decidedly inimical to the proper production of berries. The evil effect of pine needle compost to strawberry transcended the good effect of the fertilizer used. The use of ordinary compost further augmented berry yield, beyond the increase registered by the use of commercial fertilizer alone. It is better to use no compost at all than using the readily available pine needle compost.

VI. STRAWBERRY MULCHING TESTS

Object.—The object of these tests was to determine the effect on yield of strawberry with three different kinds of mulching materials; namely, pine needles, reeds, and straw, especially the first as a complement of the previous tests.

Materials and methods.—For these tests, a field was selected, which was previously planted to sweet corn interplanted with beans. It was divided into 12 standard beds of 45 sq. m. each.

The different variables or treatments were:

A. Pine needle mulch.
B. Reed mulch.
C. Straw mulch.
D. Earth mulch (check).

The variables were replicated three times, with the different beds laid out as Arrangement 1.

On June 26, 1936, ordinary compost was applied at the same amount per bed. Three days after, on June 29, the variety Hood River was planted in the beds.

One-half of the amount of Station Mixture No. 1 fertilizer was applied on August 5, while the second half was applied on September 17, 1936. After the second application, the different mulching materials were placed uniformly on their respective beds.

All the beds were uniformly sprayed with lead arsenate and soap on September 19, 1936.

Observations.—Early in October, the check beds with the earth mulch produced berries ahead of the other variables. Here and there among the different treatments berries were also noted, but not as great a proportion as in the check beds. On the whole, there was no marked difference in the foliage development of the different variables.

Results.—Harvest of the berries began on October 19, 1936, and ended on January 30, 1937. As usual, the berries picked from different beds were weighed separately. The consolidated yields of the different beds are shown in the following table.

Discussion of results.—It may be well to describe the character of the different materials used for mulching, in order to make a just appraisal of the results. As it is well known, the pine needles are fine and gave a complete cover. The dried reeds used were also fine and likewise gave good cover. The straw mulch was a mixture of barley, oats, and wheat straw. In comparison with the first two mulching materials, the straw mulch did not give a complete cover. In the check plots, the earth mulch was brought about by the stirring of the soil in the application of the fertilizer and the subsequent weedings. In the mulched beds, the weeds were pulled. The berries harvested from the earth mulched beds had some soil particles adhering to them, which fact enhanced its yield in contrast with the straw mulch.

If we compare the pine needle mulch and the reed mulch, which identically gave complete cover, the reed mulch gave better results than the pine needle mulch, and the best in these tests. Pine needle mulch, however, was superior to either the earth or straw mulch.

Summary.—Pine needle mulch does not markedly affect the yield of berries. While the dried reed mulch was superior to pine needle mulch, its exclusive use in our cultures is very limited due to lack of sufficient supply.

In relation to the inimical effect of pine needle compost shown in the preceding tests, the fact learned from the mulching tests is that pine needles can be used as mulching material for strawberries without serious effects. After the crop, the partly decomposed pine needle mulch should be gathered and taken away or burned. The field with pine needle mulch should not be immediately utilized for another strawberry crop.

TABLE 5.—*Showing the consolidated yields in kilos of berries per bed, the total for the three replications of each variable, the average per bed, and the calculated yield per hectare*

Pine needle mulch		Reed mulch		Straw mulch		Check Earth mulch	
Plot No.	Yield in kilos	Plot No.	Yield in kilos	Plot No.	Yield in kilos	Plot No.	Yield in kilos
1–A	5.32	2–B	7.45	3–C	8.06	4–D	9.60
5–A	12.54	6–B	16.09	7–C	9.52	8–D	9.43
9–A	14.40	10–B	14.72	11–C	8.67	12–D	10.67
Total	32.26		38.26		26.25		29.70
Average per bed	10.75±0.168		12.75±0.273		8.75±0.472		9.90±0.302
Calculated yield per hectare	2,388.9		2,833.3		1,944.4		2,200.0

VII. FERTILIZER TESTS OF STRAWBERRY (SERIES 11.)

Review of a Previous 3-Year Fertilizer Tests (Series 1.)—Mr. José de Leon, former Superintendent of this station, started fertilizer tests of strawberry in the 1934–35 season. The present writer continued these tests and carried them for two seasons more, 1935–36 and 1936–37, closing them last season. The object of these tests was to prove the efficiency of compost as fertilizing material for strawberry in comparison with two well known standard commercial fertilizers. The fertilizers tested were compost at one petroleum canful for 1.2 sq. m., compost plus ammophos plus sulphate of potash (20 N—20 P_2O_5—8 K_2O), ammophos plus sulphate of potash, Nitrophoska No. 3 (16.5 N—16.5 P_2O_5—8 K_2O) and check. The commercial fertilizers were applied at the rate of 1 ton per hectare. The beds were replicated three times; as in every season the 40-meter long beds ran throughout the length of the field. The Wilson variety only was used for all these tests. In the second season, 1935–36, the yields of the beds were greatly depressed due to severe strawberry thrip infestation. The consolidated results may be seen in the following table.

TABLE 6.—*Showing the yearly average yield in kilos of berries per bed or plot of the different treatments, the three-year average, the calculated yield per hectare, the increase of berries over the check and the value thereof at ₱0.30 per kilo.*

Year	Compost	Compost + ammophos + sulphate of potash	Ammophos + sulphate of potash	Nitrophoska	Check
	kilos	*kilos*	*kilos*	*kilos*	*kilos*
First	32.40	43.33	37.67	28.45	26.63
Second	10.59	15.91	15.85	13.05	11.14
Third	27.56	30.88	21.24	20.96	13.09
3-year average	23.517	30.040	24.920	20.82	16.953
Calculated yield per hectare	3,674.5	4,693.8	3,893.8	3,253.1	2,648.9
Increase over check	1,025.6	2,044.9	1,244.9	604.2	
Value of increase	₱307.68	₱613.47	₱373.47	₱181.26	

In accordance with the above results, the plot treated with compost plus ammophos plus sulphate of potash was the best, followed by the same fertilizer alone, and the third was compost. Compost-treated beds yielded slightly lower by 219.3 kilos than the ammophos plus sulphate of potash beds. It was made clear by these tests that compost is essential for good strawberry yield under our soil conditions; that ammophos plus sulphate of potash did the best in combination with compost; that, while ammophos plus sulphate of potash did better than compost, the

difference was small; and that Nitrophoska, at a cost of ₱190 per ton including freight, was unprofitable for strawberry.

The above fertilizer tests, while useful in the research regarding compost as fertilizing material for strawberry, was not very satisfactory with respect to commercial fertilizers, because it was not comprehensive enough, relying on only two commercial fertilizers, which are costly. Both these fertilizers may be good when new, approximating closely their trade compositions, and when their constituents are the only ones required by the plants; but in this country where the climate is humid, these fertilizers often reach their destination moist or wet, with their compositions greatly disturbed. This may be one reason why at certain times, they do not give the expected results.

A new series of fertilizer tests was evidently desirable, retaining the ammophos plus sulphate of potash for comparison. Four of the fertilizers used were commercial, one of which was a complete fertilizer. Sulphate of potash to make 8 per cent was added to the other three fertilizers, containing only nitrogen and phosphorus, in order to make them complete also. The other two complete fertilizers were local mixtures, which are generally used for our vegetable work.

Object.—The object of these tests was to determine the most profitable fertilizer for strawberry.

Materials and Methods.—The field chosen for these tests was of fairly uniform conditions and one of the best fields of this station. It is of interest to give the chemical analyses, made in April, 1934, by Dr. M. M. Alicante of the Bureau of Science as follows:

TABLE 7.—*Showing the results of chemical analyses of the Baguio Plant Industry Experiment Station soil sample No. 6*

	Analyses	Sample St. 6
	Lime requirement	5–10 tons lime
	pH value	5.6
Total by fusion method	Nitrogen (N)	0.229 per cent
	Phosphoric anhydride P_2O_5	0.362 per cent
	Potash (K_2O)	0.534 per cent
	Calcium oxide (CaO)	0.626 per cent
	Manganese oxide (MnO)	0.178 per cent
	Iron oxide (Fe_2O_3)	11.99 per cent
	Aluminum oxide (Al_2O_3)	16.34 per cent
	Total carbon	4.300 per cent
	Carbonate carbon	0.045 per cent
	Organic carbon	4.305 per cent
	Loss on ignition	15.04
	Copper (Cu)	0.076 per cent
	Boron (B)	None
	Magnesium oxide (MgO)	1.72 per cent

Dr. Alicante states regarding this sample:

"As regards to sample No. 6 the soil contains unusually high percentage of nitrogen but low in both phosphoric acid and potash in proportion to its nitrogen content. These results indicate the need of phosphoric acid application supplemented with nitrogen and potash.

"The soil of No. 6 should be treated with concentrated fertilizer containing nitrogen and phosphorus and with very small amount of potash."

The field was previously planted to cabbage, followed by beans, which were turned under just before using it for these tests. It was divided into 28 equal-sized beds of 25 sq. m. each. The layout of the beds, replicated four times, was as described as Arrangement 11. The variety Hood River supplied the plants for these tests.

The different treatments or variables were:

A. Ammophos plus sulphate of potash (20N—20P_2O_5—8 K_2O)
B. Leunaphos No. 2 plus sulphate of potash (16.5 N—20P_2O_5—8 K_2O)
C. Sta. Mixture No. 1 (10 N—15 P_2O_5—8 K_2O)
D. Sta. Mixture No. 2 (10 N—8 P_2O_5—6 K_2O)
E. Fertilica (10 N—10 P_2O_5—24 K_2O)
F. Pamco Leunaphos (16 N—20 P_2O_5—8 K_2O) plus sulphate of potash.
G. Check. (No fertilizer)

Planting for the 28 beds was made during August 20–23, 1936.

On September 14, 1936, one-half of the different fertilizer treatments, at the rate of one ton per hectare, was applied and the other half was applied on September 25. Thereafter the beds were uniformly mulched with pine needles mixed with grasses.

Observations.—Observations were made of the different fertilized beds in order to see the reactions of the plants. Ocular observation alone, however, failed to reveal the best among the different fertilizers. As a rule, all the fertilized beds showed dark green color of leaves and good development and height. The check beds showed poorer development and a noticeable yellowish color of leaves.

The first set of variables from A–1 to E–5 was attacked by white grubs, but the infestation was not serious.

Results.—Harvest was started simultaneously from all the beds on November 25, 1936, and was completed on April 26,

TABLE 8.—*Showing the yield in kilos of berries of the replicated beds, the total yield for each treatment and the average yield for each treatment.*

Ammophos + sulphate of potash		Leunaphos No. 2 + sulphate of potash		Sta. mixture No. 1		Sta. mixture No. 2	
Plot	Kilos	Plot	Kilos	Plot	Kilos	Plot	Kilos
A-1	8.72	B-2	7.82	C-3	6.46	D-4	10.62
A-8	15.74	B-9	17.16	C-10	18.37	D-11	21.80
A-19	15.35	B-20	15.69	C-21	15.26	D-15	10.10
A-26	15.52	B 27	15.72	C-28	13.88	D-22	13.06
Total	55.33		56.39		53.97		55.58
Average per bed	13.843 ±0.293		14.098 ±0.539		13.493 ±0.539		13.895 ±1.26

Fertilica		Pamco Leunaphos + sulphate of potash		Check	
Plot	Kilos	Plot	Kilos	Plot	Kilos
E-5	11.50	F-6	12.42	G-7	11.52
E-12	17.16	F-13	17.29	G-14	8.92
E-16	13.95	F-17	12.96	G-18	14.26
E-23	16.51	F-24	17.82	G-25	15.04
Total	59.12		60.49		49.74
Average per bed	14.780 ±0.438		15.123 ±0.573		12.435 ±0.438

1937, a period of five months. The yields of the different plots may be shown in the following table.

TABLE 9.—*Showing the fertilizer treatments, calculated yield per hectare, increase of berry yield over check and value thereof, cost of fertilizer, and gain or loss by the use of the fertilizer over check.*

Variable or treatment	Calculated yield per Hectare	Increase		Total cost of fertilizer per ton [2]	Gain or loss over check
		of berries over check	Value thereof [1]		
A. Ammophos plus sulphate of potash	*kilos* 5,537.2	*kilos* 563.2	*Pesos* 168.96	*Pesos* 181.53	*Pesos* —12.57
B. Leunaphos No. 2 plus sulphate of potash	5,639.2	665.2	259.56	137.72	121.84
C. Station Mixture No. 1	5,397.2	423.2	126.96	105.33	21.63
D. Station Mixture No. 2	5,558.0	584.0	179.20	101.18	74.02
E. Fertilica	5,912.0	938.0	281.40	145.00	136.40
F. Pamco Leunaphos plus sulphate of potash	6,049.2	1,075.2	322.56	137.72	184.84
G. Check	4,974.0				

[1] At ₱0.30 per kilo. [2] Total cost of fertilizers includes transportation and the expenses in local compounding.

Interpretation of results.—From these first season results, as graphically shown in the preceding table, it is patent that all the fertilizers gave good account of themselves in the greater production of berries over the check.

In the calculated yield per hectare and in the increase of berries over the check, the fertilizers gave yields in the following order:

1. F—Pamco Leunaphos plus sulphate of potash.
2. E—Fertilica.
3. B—Leunaphos No. 2 plus sulphate of potash.
4. D—Station Mixture No. 2.
5. A—Ammophos plus sulphate of potash.
6. C—Station Mixture No. 1.

The berries were valued at ₱0.30 per kilo, being the average price that can be obtained for all the first-class berries and culls picked during the whole season from any strawberry field.

The most important result, however, to be derived from any fertilizer test, overshadowing all other facts, is the net profit gained by the use of each specific fertilizer. The fertilizers used varied markedly in price from ₱101.18 to ₱181.53 per ton. Naturally the total outlay for each fertilizer used including transportation and the labor in mixing same has to be deducted from the corresponding increased value of yield. When

this is done the order of increase in yield does not coincide exactly with the order of net profit. The order of profit of the different fertilizers used was as follows:

1. F—Pamco Leunaphos plus sulphate of potash	₱184.84
2. E—Fertilica	136.40
3. B—Leunaphos No. 2 plus sulphate of potash	121.84
4. D—Station Mixture No. 2	74.02
5. C—Station Mixture No. 1	21.63

On account of its exorbitant cost, ammophos plus sulphate of potash registered a loss of ₱12.57, although it ranked fifth in the increase of berries over the check. This fertilizer, however, maintained its performance as obtained in the three-year results, and even registered higher yield by reason of the better soil used and the smaller plots used in these one-year tests.

The results of our second series of fertilizer tests, using cheaper forms of fertilizers and giving decidedly better and more profitable results than our old standby—the ammophos plus sulphate of potash in combination with compost—change entirely the aspect of our experimental and commercial work with strawberry in relation to the fertilizer to be preferred. This is the outstanding gain for the station derived from the second series of fertilizer tests.

Summary.—Summarizing tentatively our results we may state—

1. Pamco Leunaphos plus sulphate of potash (16 N–20 P_2O_5–8 K_2O), Fertilica (10 N–10 P_2O_5–24 K_2O), and Leunaphos No. 2 plus sulphate of potash (16.5 N–20 P_2O_5–8 K_2O) in the order named are the best and most profitable fertilizers for strawberry under our soil conditions.

2. The results of these tests in having the Leunaphos plus sulphate of potash with the 16 per cent nitrogen, 20 per cent phosphoric acid, and 8 per cent potash, are in line with the recommendation borne by the chemical analyses of the soil.

3. Based upon the constituents of Leunaphos plus sulphate of potash for our soil conditions, the proportion of the NPK constituents in the best fertilizer found may be expressed by the ratio 4:5:2.

4. Ammophos plus sulphate of potash (20 N–20 P_2O_5–8 K_2O), while it gave marked increase over the check, yet by reason of the high price per ton, turned out unprofitable in comparison with the other fertilizers used in these tests.

GENERAL SUMMARY

In the light of findings observed from a careful checking of the results of the foregoing tests, what can be recommended to strawberry growers, whose fields have similar soil and climatic conditions as those obtaining in the Baguio Plant Industry Experiment Station?

The strawberry varieties found adapted and which can be recommended with confidence to growers are Hood River and Wilson. Missionary may come next to these varieties, though its berries are sour. Of the newly introduced varieties, Narcissa especially, Clermont, and Aroma are promising. They are in process of being rapidly multiplied.

Rooted plants grown in the nursery are better and yield more than the unrooted plants freshly taken from the old clumps. These rooted plants may easily double the berry yield of the other material.

Strawberry seedlings are also good planting materials, especially if from pure strains. In spite of the unselected plantings, seedlings outyielded asexually propagated materials, such as the runners and the plants.

Seedling selection is a good method for improving strawberries for certain characters and qualities and for breeding better adapted strains from recalcitrant varieties. Several seedling strains of the varieties Wilson, Missionary, Mastodon, Bellmar, Big Joe, and Fairfax were isolated for further testing and propagation.

The partly decomposed pine needle mulch, when incorporated into the soil, was found inimical to berry production.

Pine needle mulch, however, does not significantly affect strawberry yield. After the harvest the pine needle mulch should be either gathered and thrown away or burned. The field planted to strawberry with the pine needle mulch should *not* be immediately followed by another strawberry crop.

While our previous finding with limited number of fertilizers for three years, ammophos plus sulphate of potash especially in combination with compost was the best, our recent tests comparing this fertilizer with five others showed that it was unprofitable by reason of high cost.

Pamco Leunaphos plus sulphate of potash, Fertilica, and Leunaphos No. 2 plus sulphate of potash did very much better than the ammophos plus sulphate of potash and gave the most profit in the order named. The station mixtures Nos. 2 and 1, especial-

ly No. 2 were even better in the matter of profit than the ammophos plus sulphate of potash.

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DISEASE-RESISTANT RICE HYBRIDS PRODUCE SUPERIOR YIELDS IN COMMERCIAL TRIALS

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THREE PLATES

Since the announcement of the isolation of hybrid strains of rice resistant to the rice stem rot (*Sclerotium oryzæ* Catt.) four years ago, interest in the propagation of rice hybrids proceeded with little interruption; and in 1935 sufficient seed was available to test them in Maligaya Rice Station on a small scale under field conditions. Outstanding of the rice hybrids that have been tried are Ramay [1] x Inadhica, Ramay x Elon-elon, Elon-elon x Inadhica and Ramay x Khao Bai Sri. Several derivatives of these crosses have been selected adequately through an ardous process of elimination, and although the establishment of disease-resistance has been the prime basis of selection, as it is considered the chief bulwark of defense against destructive diseases of this type, needless to say, other characters were also given due attention so as to meet squarely the demands of the planters, merchants and consumers. In every planting, the parent varieties were grown alongside for comparative purposes.

RESPONSE OF COMMERCIAL VARIETIES TO STEM ROT

Of the twenty commercial rice varieties that have been previously subjected to artificial inoculations, or to natural conditions of exposure in heavily infested soils,[2] all showed suscep-

[1] This variety, introduced into the Philippines in 1919 by Ex-Director Fidel A. Reyes of the former Bureau of Commerce and Industry, is popularly but erroneously known locally as "Ramai." For consistency and to give due credit to its country of origin, French Indo-China, its correct Malayan name should be retained and written thus, "Rá-mây," as shown in an article by M. J. Robin, entitled "Les différentes variétés de riz cultivées à la Station de Cantho" in Bulletin Agricole de l'Institut scientifique de Saigon, 2e Année, N° 2, 40–45, Fevrier 1920. The "Ramay" form of writing is obviously closer to its original nomenclature and should be acceptable and made official for facility in writing and for uniformity of usage.

[2] Reyes, G. M. A preliminary report on the stem-rot of rice. Philippine Agricultural Review 22 (1929) 313–31, Pl. LIV–LXIII.

tibility in varying proportions to stem rot (Plate 1). None of the more popular native varieties exhibited complete freedom from the disease, although Macan Biñan showed fairly good resistance, while the exotic varieties, Ramay and Elon-elon, were moderately resistant, showing commendable superiority over the age-worn local sorts. These resistant varieties, however, have disadvantages which make them unpopular for general planting; showing that none of our existing varieties is wholly satisfactory in all respects. Efforts are directed therefore towards producing new varieties that combine disease resistance with hardiness, productivity and good eating quality and present development seems well on the road towards this end. This mode of approach offers great possibilities of relief to our local rice growers, a task which finds its natural opportunity for expression with amateur plant breeders and plant pathologists.

FIELD OBSERVATIONS, 1934–1935

In September, 1934, a trip was made to Maligaya Rice Station,[3] Nueva Ecija, and a thorough-going inspection of the rice fields revealed the following facts:

1. The stem rot of rice was accentuated in Maligaya Rice Station by the prevalence of warm, humid weather and other contingent environmental factors.

2. In the trial plantings of the new rice hybrids grown side by side under natural conditions, Raminad Str. 3 [4] showed considerable resistance to the attack of *S. oryzæ* (Plate 2), while strains 1 and 2 of the same cross showed some unmistakable signs of attack, indicating fairly well their reaction to the disease.

3. Ramay and Elon-elon were very little affected by the stem rot disease, while Khao Bai Sri, Dinalaga and Inadhica showed susceptibility in their descending order. This varietal response to the disease (excepting the variety Dinalaga) confirmed the writer's previous findings in Alabang Stock Farm, Rizal Province and in Santa Ana, Pampanga.[5]

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[3] Reyes, G. M. Report on a survey of rice diseases in Maligaya Rice Station in 1934. Unpublished.

[4] Reyes, G. M. Rice hybrids versus stem rot disease. Philip. Journ. Agric. 7 (1936) 413–417. Pls. 1–3.

[5] Reyes, G. M. Op. cit.

Reports from other rice-producing regions revealed that in 1934 the stem rot of rice was also rampant; serious outbreaks of which have been corroborated from specimens received for diagnoses. Weather conditions exceedingly favorable for the progress of the disease at that time afforded an unusually severe test for varietal resistance. In 1935, Dr. Juan P. Torres, plant breeder of the Bureau of Plant Industry, in a verbal communication to the writer confirmed the previous observation that Raminad strain 3 was the most resistant of all the hybrid rices that have been multiplied in Maligaya Rice Station, in spite of the heavy infestation noted the preceding year.

While the hybrid rice, Raminad strain 3, has not been planted sufficiently long in many rice regions, except in Nueva Ecija, to warrant a fully reliable conclusion, yet the three years plat test conducted in Maligaya Rice Station have demonstrated the worth of this resistant segregate and the results have been quite promising under natural conditions, that it seems as though the planting of this hybrid strain will rapidly increase judging from the many requests for seed of this resistant hybrid strain. Everything being equal there seems little doubt that it will do equally well in other rice regions.

The superiority of Raminad strain 3 (Plate 2) with reference to productive capacity over its sister strains may be gleaned from Table 1.

TABLE 1.—*Comparative yield of strains of a hybrid (Ramay ♀ x Inadhica ♂ F_8) and of the parent varieties under field conditions* [a]

Variety or strain	Mean yield per hectare	Difference (+ or —) [b]	
		Over Ramay	Over Inadhica
	Cavans	*Cavans*	*Cavans*
Ramay	67.0±2.10		
Raminad Str. 1	61.9±0.87	−5.1±1.72	+ 5.8±1.31
Raminad Str. 2	68.9±0.81	+1.9±1.70	+12.8±1.29
Raminad Str. 3	74.3±1.07	+7.3±1.78	+18.2±1.39
Inadhica	56.1±0.87		

[a] From 1935 plat trials (5 replications, plants planted singly) conducted in Maligaya Rice Station, Bureau of Plant Industry. Figures supplied by the agronomy section.

[b] Plus or minus sign means increase or decrease.

From Table 1 it is thus apparent that Raminad strain 3 leads all the strain selections from the cross, Ramay ♀ x Inadhica ♂, in yielding capacity, exceeding also the female parent variety

by 7.3 cavans and outyielding by a respectable margin the male parent by 18.2 cavans.

It appears evident that the tolerance of Ramay to *Sclerotium oryzæ* has been carried over to at least one of its hybrid progenies manifesting in a marked degree in Raminad strain 3;[6] it having been demonstrated previously that Ramay is possessed of some natural inherent resistance to the rice stem rot while Inadhica is rather susceptible to it. Aside from the possession of desirable agronomic and market qualities, this hybrid strain is valuable because of its relatively higher degree of resistance to the rice stem rot and to the brown linear spot (*Cercospora oryzæ* Miy.).

COMMERCIAL TRIALS, 1935–1936

In commercial plantings conducted in Maligaya Rice Station during the regular rice seasons, 1935–1936 and 1936–1937, the available data furnished by this station[7] as to the comparative yield of rice hybrids and their parent varieties are shown in Table 2.

TABLE 2.—*Comparative yield of rice varieties and hybrids (F_9 and F_{10}) in commercial trials in Maligaya Rice Station*

Hybrid or parent variety	1935–1936 season		1936–1937 season		Average yield
	Days to maturity	Yield per hectare	Days to maturity	Yield per hectare	
		Cavans		*Cavans*	*Cavans*
Ramay	--------	Ave.–53.10	--------	Ave.–54.42	53.76
Ramay × Elon-elon Str. 1	187	74.31	189	85.34	79.82
Ramay × Elon-elon Str. 2	192	76.79	189	66.17	71.48
Ramay × Elon-elon Str. 3	181	55.22	187	67.09	61.15
Ramay × Elon-elon Str. 4	186	58.67	186	32.46	45.56
Elon-elon	--------	Ave.–54.70	--------	Ave.–59.41	58.40
Elon-elon × Inadhica Str. 1	183	46.60	178	54.11	50.35
Elon-elon × Inadhica Str. 2	186	56.30	185	64.09	60.19
Elon-elon × Inadhica Str. 3	179	45.73	176	61.52	53.62
Elon-elon × Inadhica Str. 4	196	49.83	190	70.18	60.00
Elon-elon × Inadhica Str. 5	183	50.69	181	68.02	59.35
Inadhica	--------	Ave.–52.00	--------	----------	52.00
Ramay × Khao Bai Sri Str. 1	191	49.83	185	77.90	63.86
Ramay × Khao Bai Sri Str. 2	194	51.99	189	77.29	64.64
Ramay × Khao Bai Sri Str. 3	183	54.79	191	72.34	63.56
Khao Bai Sri	--------	Ave.–31.88	--------	Ave.–59.95	45.66
Khao Bai Sri × Guinangang Str. 1	138	44.42	146	43.88	44.15
Ramay × Inadhica Str. 1	190	50.26	188	61.69	55.97
Ramay × Inadhica Str. 3	192	91.33	198	91.31	91.32
Ramay × Inadhica Str. 4	190	73.91	193	71.19	72.55
Ramay × Inadhica Str. 5	199	58.25	190	80.59	69.42

[6] Reyes, G. M. Op. cit.

[7] Through the courtesy of Mr. Ramon V. Manio, acting superintendent.

A careful examination of the preceding table will reveal the unmistakable fact that there was almost a general increment in the yield of the varieties and hybrids in the second year planting. For comparative purposes, their periods of maturity are also given to serve as guide to planters. Of the hybrids that gave fairly high yields in both seasons were Ramay x Elon-elon strains 1 and 2, and Ramay x Inadhica strains 3 and 4. They also show promise of being commercially important for possessing desirable market or agronomic qualities. It is highly interesting to note that the hybrid selection, Raminad strain 3 outyielded all the varieties and hybrids that have been propagated by the Maligaya Rice Station as can be readily seen in Table 2. It is considered one of the most prolific hybrid varieties and its performance during the two seasons in small commercial scales showed clearly its superiority over the other hybrids, hence the release of the seeds this year. As to Raminad strain 4 (Plate 3), although possessed of especially desirable characteristics and a fairly good yielder, it cannot be recommended for general planting owing to the facility with which it succumbs to stem-rot infection, while Raminad strain 1 was found quite unsatisfactory in more respects than one (Plate 3).

Small quantities of seed of this new hybrid strain, Raminad strain 3, were given away free by the Maligaya Rice Station to farmers for coöperative trial plantings with the object of ascertaining its performance when subjected to differences of existing growing conditions. As we know varieties do not produce the same in all localities with varying conditions, and changes of environment may affect also the resistance or susceptibility of a variety. The results of these tests, according to the 1936 Annual Report of the Director of Plant Industry were very encouraging. This hybrid strain together with Ramelon are now being propagated more extensively in the different rice stations of the Bureau of Plant Industry for the purpose of raising seeds for general distribution. This prompted the release of this brief note. By the way, the seeds are not given free of charge; but even at the rather exorbitant Government price of ₱3.50 a cavan, the demands for seed could not be met as yet. All available seed has been bought up early by eager growers who are always interested in experimental work and always on the alert to try new and improved varieties reputed to combine yielding ability, quality and resistance to disease. It would be interesting what these seed buyers would report after their first planting, and it would be more interesting,

indeed, if this new hybrid strain could be grown in various regions in areas where natural epidemics of the disease are known to have occurred in the preceding season. Such natural exposures would find more suitable expression of its real worthiness under existing soil and climatic conditions as well as to other deterrent factors. This is also of vast importance for the reason that it would find greater opportunities of contact with other possible new biologic forms of the causal organism. If one is looking for something new in rice, this hybrid strain is recommended, especially so from the production standpoint as well as for other desirable qualities. Seed growers should be particularly interested in it at this stage of the game, but the economic importance of this hybrid strain depends upon how careful the seeds are handled in all operations [8] and kept free from admixture of other varieties. The rice growers depend on the reliability of the seeds they buy which should be certified and taken to mean as 100 per cent pure, and free from destructive diseases or pests, or from weed seeds. The best time to select for seed for general propagation is just before the crop is harvested, after the heads are fully matured.

SUMMARY

1. A new variety of rice has been developed which is attracting considerable interest among rice growers. Raminad strain 3 is the name given to the new promising variety, showing a decided improvement over the parent varieties. It is bound to become popular because of the possession of certain desirable fine qualities, being a good yielder, besides offering complimentary resistance to the rice stem rot.

2. Outstanding of the resistant hybrid strains, it was noticeable in two demonstrations under field conditions that Raminad strain 3 was easily the heaviest yielder.

[8] Meticulous care should be taken as regards sowing and planting, harvesting and threshing, drying and storing, where mixtures of varieties or seeds are likely to happen.

ILLUSTRATIONS

PLATE 1

A plat of a susceptible variety, Macan I, showing severe infection by the stem rot disease caused by *Sclerotium oryzæ* Catt. Only a few panicles can be discerned in the rear plants in a total of one hundred plants, and complete sterility or stunting of plants in the foreground. (Photographed by G. M. Reyes.)

PLATE 2

Individual rice plants cut at ground level, representing graphically the response of hybrid strains and their parent varieties to *Sclerotium oryzæ* Catt. (Photographed by G. Panlilio of the Bureau of Science, Manila.)

PLATE 3

Plants of two susceptible rice hybrid segregates showing in a measure the degrees of infection caused by *Sclerotium oryzæ*. Note and compare the plants carefully. (Photographed by G. Panlilio of the Bureau of Science, Manila.)

PLATE 1.


COMPARATIVE RESISTANCE OF RICE HYBRID SEGREGATES TO STEM ROT
REPRESENTED GRAPHICALLY BY THE NUMBERS OF PLANTS USED
STRAIN 1
STRAIN 3
STRAIN 4
INADHICA

PLATE 2.


GRADES OF RICE STEM-ROT INFECTION
SEVERE
MODERATE
SLIGHT
HEALTHY PLANT
SEVERE
MODERATE
SLIGHT
HEALTHY PLANT
RAMAY × INADHICA STR.1
RAMAY × INADHICA STR.4

PLATE 3.

FARMERS' CIRCULAR SECTION

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CIGAR WRAPPER LEAF TOBACCO CULTURE

Farmers' Circular 15

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THREE PLATES

Choice of varieties.—For shade culture, the native varieties *Vizcaya* and *Marogui* and for open cultures *Baker Sumatra* and *Ilagan Sumatra* are recommended. In the Ilocos Provinces the *Sumatra* varieties are also made to produce extra fine wrapper by shading them.

Soil requirements.—Wrapper tobacco has been successfully grown in well drained soils ranging from silty loam to sandy loam of at least more than normal fertility. Virgin soils are of course the best. The small valleys that abound in the Ilocos Provinces because of yearly deposits of rich sediment from the surrounding hills and mountains are also ideal for wrapper tobacco.

Climatic requirements.—In regions of well defined dry and wet seasons like the Ilocos Provinces shade culture are the rule, whereas in those with short dry periods like the Cagayan Valley or with an even distribution of rainfall like Cotabato Valley, open cultures are quite practicable. In the interior valleys of the Ilocos Provinces, however, because of the reduced daylight, open cultures are also practicable. And in the lower and middle reaches of the Cagayan Valley because of delayed planting on account of the yearly floods up to the last week of November, shade cultures have to be resorted to.

The optimum seasonal periods of field operations for wrapper tobacco in the Ilocos Provinces and Pangasinan are as follows:

1. Sowing of seeds ..... October 1st to 15th.
2. Transplanting ..... November 25th to December 15th.
3. First harvest ..... January 20th to 30th.
4. Curing period..... From 25 to 30 days.

5. No. of priming (harvest) ..... From 8 to 12 days.
6. Intervals of harvests.. From 5 to 7 days.

The above data apply to the native varieties. For the *Sumatra varieties* the intervals between the field operations are slightly reduced.

The optimum seasonal periods of field operations for wrapper tobacco in the lower and middle reaches of Cagayan valley are as follows:

1. Sowings of seeds ..... October 10th to 15th.
2. Transplanting ..... December 1st to 20th.
3. First harvest ..... February 1st to 15th.
4. Curing period ..... From 27 to 32 days.
5. No. of priming (harvests) ..... From 8 to 12 days.
6. Intervals of harvests.. From 5 to 7 days.

In the upper reaches the sowing of seeds can be started as early as the middle part of September, the seedlings being ready for transplanting within about 45 days if the *Sumatra* varieties are grown. It does not usually pay to plant *Sumatra* varieties in the Cagayan Valley late in the year.

Location and preparation of seed beds.—A well drained, loamy and rich portions of the field near a good water supply should be selected for the seedbeds.

In August and the early part of September, the land is to be plowed and harrowed until the soil becomes pulverized and the plot divided into beds 1.2 meters wide and 10 meters long. The beds should be separated from each other by paths from 30 cm. to 1 meter wide. The soil dug from the paths to a depth of about 10 cm are transferred over the beds, thus raising them. The low paths will serve as drainage canals. Each seedbed must be provided with a portable nipa or cogon shed to protect the seedlings from the rain and intense heat of the sun. The front side of the shed should be raised about a meter high and the other side about 75 cm from the ground. The sheds should face the east in order that the seedlings receive the mellow heat of the morning sun but not the strong afternoon sun.

The final preparation of the seed beds consists in working the soil with hand tools until the soil particles become well pulverized.

Sowing of seed.—Before sowing the seed, it is always advisable to test the percentage of germination. The simplest method is to place 100 seeds between two pieces of blotting paper on a clay plate with a cover to fit, and then keep the blotting papers moist for one week. Then the percentage of germination can be determined by counting the number seeds which have germinated. Five or six grams of seed with a percentage of germination ranging from 70 to 100 per cent will be a sufficient quantity to sow in one bed that measures 1.2 by 10 meters. Before the seed is sown, the beds should be sterilized by pouring boiling water over them. The uniform distribution of seed in the bed is insured by mixing it with about 10 parts of wood ash or fine sand before sowing.

Each seed bed of the size mentioned above will produce not less than 1,000 seedlings, so that about 20 beds will be required for every hectare of native varieties, and 30 beds of the *Sumatra* varieties. It is always practical to sow a set of extra beds after two weeks as a precaution against adverse conditions.

When there are many red ants in the seed bed there is always danger of their carrying away the seeds. To prevent this it is a good plan to scatter corn meal made into a mash with sugar along the borders of every seed bed. The bait will attract the ants from the seeds.

Care of seedlings.—The soil in the seed beds should be kept moist all the time. Weeds of any kind should be pulled up as fast as they appear. If the seedlings are attacked by damping off disease all the infected ones, including the few healthy ones around the infected areas, should be removed together with the soil. Treating the infected area with 5 per cent formaline solution will minimize further infection.

Crowded areas in the seed bed are to be thinned so that the remaining seedlings will be about 4 cms. apart.

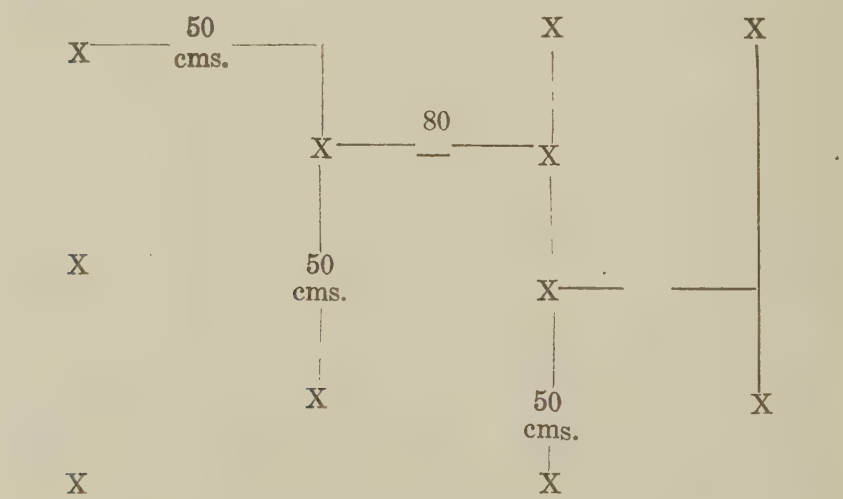
About two weeks before transplanting, the sheds of the beds are to be removed to expose the seedlings to the sun to make them strong.

Preparation of the field.—The land must first be thoroughly cleaned of weeds and stumps and then plowed and harrowed at least twice or until it becomes well pulverized. One or 2 days before planting furrows should be made in the field 80 cm. apart in the case of native varieties and shade cultures. The native plow is appropriate for this purpose.

It is not advisable to prepare furrows in open cultures of the Sumatra varieties but instead the rows should be marked off with pegs and strings, since there are two alternate distances between the rows.

Planting.—The seedlings are ready for transplanting in 45–60 days. Before pulling the seedlings for transplanting the beds should be watered to virtual saturation to make the soil soft, thereby preventing unnecessary breakage of the root systems of the plants. Only healthy and vigorous seedlings are to be selected for planting. Holes of sufficient depth equal to the length of the root system should be made with a trowel along the furrows, 70 cm. apart for the native varieties and in shade cultures.

In open cultures of the *Sumatra* varieties, the rows are indicated with strings marked every 45 or 50 cms. to show where the holes are to be made for setting out the seedlings. The rows should be alternately 80 and 50 cm. apart and the plants so set out that the quincunx arrangement is obtained (see accompanying diagram). This method of planting is based upon practices in Sumatra.



Showing Sumatra method of planting wrapper tobacco

Cultivation.—As soon as the plants become well established in the soil the field is ready for the first cultivation. In the shade culture the native plow is the appropriate implement, the operation consisting only of plowing twice between the rows. The cultivation in the open cultures really consists of banking,

which is completed in two operations. Banking is done by hoeing the middle of the widest distances between rows and placing the hoed up soil on the shorter spaces so that these are finally converted into beds. The depths of the resulting ditches depend on the rainfall, as these are intended incidentally for drainage. The maximum depth, however, should be 50 cm. Banking is also a Sumatra method. The operations should be completed within 20 days after transplanting.

Control of pests and diseases.—Of all the insect enemies of the tobacco plant, the cut-worms are the most destructive. Control is effected by dusting the plants with calcium arsenate. It is prepared by mixing one part commercial calcium powder with 16 parts of sterilized road dust. A bamboo tube with a node at one end and the other end covered with cheesecloth or fine meshed wire will make a cheap and practical duster. The dust is applied to each individual plant by shaking the tube to make the powder pass through the cheesecloth or wire until the leaves are sufficiently covered with a thin layer of the mixture. Occasional hand picking insures the perfect control of the worms.

Occasionally, plant lice also become very serious pests besides being responsible for the spread of the mosaic disease. Spraying with a solution of Blackleaf No. 40, a nicotine preparation, will control these insects. The solution is prepared by diluting every 150 cc. of the chemical with 5 gallons or the equivalent of one petroleum canful of water.

The safest guide to follow in controlling the fungus diseases of tobacco is to practice sanitation even to the extent of pulling up all the plants showing a diseased condition, especially those attacked by mosaic and wilt diseases. It is better to destroy a few plants rather than let the disease spread in the field.

Topping.—Topping should not be done as a rule unless the plants are extremely under-developed as this will tend to produce leaves that are too coarse. It is the desire to produce leaves with a fine body so that if topping is practiced at all only the flower buds are to be pinched off as they appear.

Seed selection.—The seed for subsequent planting should be taken only from healthy and vigorous plants. The plantation should be gone over thoroughly when the crop is about to flower and the finest and soundest plants selected. To keep the seeds pure the entire flower head of each individual plant should be covered with a 10–12 pound Manila paper bags before the

flowers open and until the seed pods are fully developed. When the capsules are matured they are cut off from the stem of the mother plant and hung inside the shed for thorough drying. The capsules are matured then to be hulled, and the seed stored in air tight containers. The seeds, if stored properly, will remain viable for at least two years.

The shade tent.—The frame work of the shade tent should be erected as early as practicable, so that by the time the plants are about half a meter high, the shading material (coconut leaves, talahib, cogon, banana leaves, etc.) can be placed over the frame without delay and as rapidly as possible. This is very important to obtain uniform texture of leaves. The posts of the shade tents should not be less than two and a half meters high from the surface of the ground. They should be set deep enough to enable them to resist windy spells. The posts should be erected in every four to five rows of tobacco crosswise and six to eight rows lengthwise. Once the tent is complete, cultivation is automatically stopped. In the case of native varieties, the shade should be dense enough to reduce sunlight inside by 40 per cent, while for the Sumatra varieties the sunlight should be reduced to 60 per cent only. In both cases, the shading materials should be evenly placed to insure a uniform penetration of sunlight.

Harvesting.—As the greatest uniformity of product is desirable, the leaves should be picked or primed from one to three at a time, as they show the slightest change in hue to lighter green, which shows the importance of bearing in mind the characteristic greenness of the immature leaves from the start.

The leaves are best harvested when they are in the most turgid condition, that is, during the early hours of the morning. And as many should be brought into the curing shed as can be strung or poled the same day.

Stringing and poling.—As soon as the leaves are gathered from the field they should be taken immediately into the shed where all broken and worm-eaten leaves are sorted out.

Stringing is done by passing a needle threaded with twine or string through the petiole of the leaves. About 100 leaves are arranged, preferably face-to-face and back-to-back and about one centimeter apart, on the string. Each end of the string is attached to a pole of practically the same length as the string, and about 2 to 4 cms. in diameter. If bigger curing

barns are available, longer poles and strings can be used. This method of poling originated in Cuba.

Native sticks can also be used provided the leaves are to be stuck just as described.

In the curing shed the poles are hung lengthwise of the building in such a way that the leaves of different poles do not touch each other and each section of the shed is filled from the highest to the lowest racks.

The curing shed and the curing period.—The curing shed should be spacious, provided with plenty of windows at the ends and at least one-half the sides made up of equidistant swinging doors, while the posts need to be substantial and durable. The roof and walls should be of an insulating nature and for reasons of economy, can be either cogon or nipa. The building may be of any size not less than 14 meters in width nor less than 3 meters high to the eaves, depending on how frequent and fierce typhoons are in the locality. What is important is that there should be available space of at least 900 cubic meters for every hectare planted.

Because of saprophytic fungi attacking the leaves in the shed when it gets too humid (more than 84 per cent relative humidity) it is often necessary to heat the curing shed until the danger is past. As the shed contains leaves, the draft and heat should be kept under control so that the slow and natural drying of the leaves will not in any way be either hastened or retarded.

Fermentation.—When the leaves have completely cured, that is, even the midribs are completely dried out and they are in the so-called "neither dry nor moist condition," they are ready to be unstrung, bundled into 50's and piled for fermentation.

Owing to their fine texture, they can stand greater heat to advantage than any other type of tobacco, the lowest being 56°C. The Sumatra method of fermenting whereby a lot of leaves weighing from 1,000 to 2,000 kilos are initially bulked and gradually combined arithmetically 3 times ought to be sound practice inasmuch as it is generally followed in that island.

But in the tobacco stations of the Bureau of Plant Industry where wrapper tobacco could never be raised on a commercial scale it has been shown that with small piles, 2 by 2.5 meters and the height equivalent to 29 to 30 layers, wrapper tobacco can be allowed to heat to 56° C. without any adverse conse-

quences. The fermenting piles should, of course, be rebuilt the moment the desired temperature has been obtained reversing the position of the leaves in order to insure uniform fermentation of all the leaves in the pile.

Preparation of product for the market.—After fermentation the leaves are to be sorted on the basis of color, soundness and size: bundled into 25's and 40's and baled with the cheapest mattings like pandan, available locally. Every bale should contain 50 kilos of wrapper leaf tobacco not only in compliance with Internal Revenue regulations but for convenient handling.

ILLUSTRATIONS

PLATE 1

FIG. 1. An individual plant of the Viscaya variety.
2. An individual plant of the Simmaba variety.

PLATE 2

FIG. 1. A good stand of tobacco seedlings of the Simmaba variety 45 days old ready for transplanting.
2. A plantation of shade-grown Sumatra, Los Baños Economic Garden, Los Baños, Laguna, harvesting practically through. The tent used is of abacá cloth.

PLATE 3

FIG. 1. A partial view of an open-grown Sumatra plantation, Central Experiment Station, Bureau of Plant Industry, Manila. Note the vigorous stand of the plants.
2. An ideal curing shed for wrapper leaf tobacco. The curing shed should be provided with adequate ventilations.

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PLATE 1.

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PLATE 2.

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PLATE 3.

CONTROL OF INSECTS AND OTHER PESTS

Farmers' Circular 20—Revised

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TWELVE PLATES

INTRODUCTION

The objects of this circular are to help acquaint planters with the different methods of combating plant pests, insects in particular, and to give directions especially on the application of the most common insecticides. This work also acquaints them with some of the new substances which have been found to be more or less satisfactory substitutes for arsenical compounds. In short it is intended as a plant pest control guide to planters in particular.

The many methods employed for the control of plant pests, of which insects are the most numerous and the most important, are usually grouped by authors into two classes, namely, the direct and indirect methods. The first group consists of the use of chemicals in the form of spray, dust, fumigants, repellants, etc., killing the pests by beating, burning and other mechanical means. The second consists of cultural measures, such as crop rotation, use of resistant varieties, use of parasites, birds and other natural enemies, etc.

In the control of insects and other pests, all possible methods should be employed. Some people are apt to think chiefly of chemical control, spraying, for instance, whenever their plants or crops are troubled by certain pests, forgetting that such methods as handpicking, collecting the insects by means of certain devices, cultural measures, taking advantage of the help of natural enemies, etc., are also productive of results when judiciously employed. Others also wish for such things as "viruses" with which plant pests may be inoculated and thus wiping these out, as if by miracle. While insects and other pests, like other living

things, are attacked by fungi, bacteria, insects, etc., these parasitic organisms are useful only to a certain extent and should not be expected to do the whole job. Still other people think of certain compounds which may be injected into plants and thus make these at least disagreeable to pests and thus keep them away. Let the public be warned about using advertised compounds alleged to possess such power. They have been found to be worthless and even injurious to plants.

It is important that one should have a knowledge of the nature, the life history and habits of the pest intended to be placed under control in order to be able to apply intelligently, effectively and profitably the measures against it. One of the things, for instance, that one should know is how an insect, for example, injures the plant—whether it bites the plant or suck the juices. The choice of the right chemical to use depends on these. Other things that should be known are: (1) where and how the insect lays its eggs, (2) how the young live and how long it takes them to become adults, (3) where the adults spend most of their time, (4) what other food plants they have, etc. The aim is to know the "weak spots" in the life of the pest so that efforts may be directed against those "weak spots" and thus more effectively control the pest. These data in connection with any pest may be obtained from the Bureau of Plant Industry and if not available the Bureau may secure them by conducting the necessary research work.

CHEMICAL METHODS (INSECTICIDES)

STOMACH POISONS (For killing, biting or chewing insects, such as "worms" or caterpillars, beetles, grasshoppers, etc. See Plates 3, 4 and 5).

Calcium arsenate powder (basic).—The amount to use is from 1.8 to 3 grams per liter of water, or 8 to 14 spoonfuls (levelful) to every petroleum canful of water depending on the plant and on the tenderness of the leaves of the plant. The spray should be *stirred well before, and now and then, during the spraying. A pump with a good nozzle that will deliver the spray in a fine mist* should be employed. A bucket pump, preferably one with an air chamber, may be used. It should have a rubber hose of convenient length and with a good nozzle that will deliver the spray in a fine mist. This will serve the purpose. In spraying tall trees, a bucket pump should be provided with a long rubber hose. In order to spray the highest parts of the trees, the end of the hose should be tied to the end

of a pole long enough so that the operator can raise the end of the hose and thus spray all the upper parts of the trees.

For spraying commercial orchards, it may prove more economical and will certainly be more effective to use a power spray or a barrel pump mounted on a cart or sled.

For spraying vegetables and ornamental trees and low trees, a compressed air sprayer or a knapsack sprayer is very convenient, as either one can be operated by one person.

Calcium arsenate may also be used for dusting, either pure or mixed in the proportion of one part of calcium arsenate to 1 to 5 parts by volume of "gawgaw" (cassava starch) or other fine carrier. The two should be mixed thoroughly. It is preferable to dust in the morning or late in the afternoon. For dusting, an ordinary rice gunny sack or a cheese cloth or "sinamay" bag may be employed. However, it is better to use an ordinary crank or bellow duster, which can be purchased from hardware stores in Manila. A clean, dry wide-mouthed bottle or a clean tin can or bamboo joint can be used for dusting plants, like garden and ornamental plants. The mouth of any one of these containers should be covered with "sinamay" or cheese cloth which allows the powder to pass through easily. It is not advisable to dust when there is a strong breeze, as much of the powder will be lost.

Lead arsenate powder (basic).—Like calcium arsenate, lead arsenate is used for killing "worms" or caterpillars, beetles, grasshoppers, and other biting insects feeding on the leaves of trees and vegetables. The amount to use is 2.3 to 4 grams per liter of water, or 6 to 12 spoonfuls (levelful) to every petroleum canful of water. The spray is applied like calcium arsenate. For spreader, a small quantity of soft, yellow laundry soap may be used—say 3 to 5 grams soap per liter of water. The soap should be dissolved first and the lead arsenate added thereafter. If there are plant lice or other sucking insects, the amount of soap may be increased.

LEAD ARSENATE FOR DUSTING

Like calcium arsenate, lead arsenate can also be used for dusting, either alone or mixed with a carrier in the proportion given for calcium arsenate, that is one part of lead arsenate to 5 parts of the carrier by volume. The amount of carrier may further be increased, for the sake of economy, if trials show that a weaker mixture will satisfactorily control the pest concerned.

Both calcium arsenate and lead arsenate (especially the former) are widely employed in the Philippines for controlling such pests as tomato worms (*Heliothis assulta*), the 28-spotted beetle (*Epilachna 28-punctata*) and cabbage worms (*Crocidolomia binotalis* and *Plutella maculipennis*). A fifty-fifty mixture (by volume) of calcium arsenate and "gawgaw" is extensively employed for dusting against locust hoppers, *Locusta migratoria manilensis* Meyen, (Plate 6) while roosting on grass, sugar cane, etc., and armyworms, like the grass armyworms, *Spodoptera mauritia*.

Paris green.—Paris green is seldom used now for spraying, but if available, it may be employed according to the following standard formula:

Paris green	150 grams
Quick lime (unslaked)	450 grams
Water	190 liters

On a small scale the following formula may be used:

Paris green	2.5 teaspoonfuls
Quick lime	5 teaspoonfuls
Water	1 petroleum canful

The lime should be slaked first and then the Paris green is added and the two mixed thoroughly. The necessary amount of water should be added and the whole stirred before, and while, spraying.

Paris green can also be used for dusting by mixing it with a carrier, such as "gawgaw" or ordinary inert lime, in the proportion of 1 part of Paris green to 10 to 20 parts by volume of the carrier. The two should be mixed thoroughly. A dry barrel or a drum (such as an empty calcium arsenate or lead arsenate drum) with a tight-fitting cover may be used for mixing. The ingredients should be put into the barrel and this is closed afterwards and then rolled as long as possible until the ingredients are thoroughly mixed. A dozen or more good-sized gravels or stones put into the barrel with the chemicals will facilitate the mixing during the rolling. A barrel mounted on axles and provided with a handle will make a convenient apparatus for mixing arsenicals and other dry insecticides with their respective carriers or fillers.

PARIS GREEN AGAINST WHITE ANTS OR "ANAY"

Paris green has been, and is being employed, in other countries, and in the Philippines to some extent, for combating white ants or termites. The powder is applied into the galleries,

runaways, or covered passages of the insects by means of suitable blowers or duster. The powder sticks to the bodies, legs and antennae of the insects and when they lick each other they accidentally swallow some of the poison and when they return to their nest they may also poison the others and possibly the queen and young also.

Paris green should be applied directly into the nest when this has been located.

SUBSTITUTES FOR ARSENICALS

There are now certain compounds that are used as subsitutes for arsenicals. Among these are the so-called cryolites, of which there are different forms. Other compounds are sodium fluosilicate, barium fluosilicate and derris, etc.

The objections commonly raised against arsenicals for application on fruit trees and vegetables, because of the residues, have prompted the search, especially in the United States, for other compounds which are not or are less poisonous to man and whose residues are easier to remove from fruits.

Among other new compounds, which have been tried by chemists of the United States Department of Agriculture are nicotine oil emulsions, nicotine bentonite and peat mixtures, diphenylamine (a common aniline derivative) and phenothiazene, which is said to be a compound of carbon, hydrogen, nitrogen and sulphur. Phenothiazene is said to be prepared by mixing diphenylamine and sulphur. The directions for using each of the cryolites and fluosilicates as a dust or as a spray, as the case may be, are usually given on each package or container.

White arsenic powder (commercial).—White arsenic is not safe for spraying plants. One of its uses is for poisoning rats. The poison may be applied in several ways. It may be mixed dry in the amount of two to four spoonfuls (levelful) to a chupa of boiled rice (about one condensed milk canful) boiled and mashed camote or shredded coconut, or with a mixture of any of these, the whole to be thoroughly stirred so as to insure an even distribution of the arsenic. The bait should be placed in bamboo tubes (large enough for the big rats to get into) when there are loose domestic animals or when it is raining. Chickens will be poisoned if they eat this bait. The bamboo tubes with poisoned bait inside should be placed where the rats pass or at the entrance to their burrows or mounds or in the infested field. The poisoned bait should be set late in the afternoon. Another method is to split a ripe banana, boiled

camote, or section of sugar cane and on the split surface a quantity of the poison is applied after which the halves should be pressed together as formerly. These articles should be placed singly about the fields where the rats are present.

When the rats are in burrows either carbon bisulphide or calcium cyanide, as mentioned later in this work, may be employed for killing the rats therein. The holes should be closed firmly with earth after the chemical has been applied in order to prevent the escape of the gas.

WHITE ARSENIC FOR BAITS FOR INSECTS

White arsenic powder is very commonly used with baits for locusts, cutworms, armyworms, crickets, mole crickets, etc. However, Paris green may also be used.

Formula

Rice bran	4 petroleum canfuls
White arsenic (or Paris green)	1 salmon canful
Molasses mixed 50–50 with water (by volume)	Add enough of the molasses and water little by little and mix with a clean shovel or other suitable tool until the whole is uniformly moist (not mashy). 10 to 20 salmon canfuls of the diluted molasses are usually enough.

The bran and the white arsenic (or Paris green) should be mixed thoroughly before the molasses is added. The poison bait should be scattered or broadcasted in the places infested, preferably late in the afternoon, in the case of cutworms, armyworms, crickets and mole crickets. In the case of locusts, the bait may be applied either late in the afternoon or early in the morning and around the places where the locust hoppers (nymphs) roost for the night. The bait may also be applied on trails and on relatively clean or barren grounds through which the hoppers are marching.

For locusts, fine bagasse has been found to have given better results than rice bran. But in the absence of rice bran and bagasse, sawdust has also been found to be a good substitute.

Baits should be applied soon after preparation as they deteriorate and lose their effectiveness with age. Care should be taken that domestic animals do not get access to the poison bait, as well as to grass dusted with arsenicals.

WHITE ARSENIC FOR WHITE ANTS OR "ANAY"

The use of Paris green against white ants has been described. White arsenic may be employed instead of Paris green for the purpose.

White arsenic for wild hogs.—White arsenic may also be used against wild hogs and "camote" or sweet potato may be used as bait. Holes should be bored into the potatoes. The holes should then be covered tightly with camote parts or borings so as to prevent the white arsenic from falling off. The tubers should then be put in places frequented by the hogs.

Another method of using white arsenic against wild hogs is to mix it with molasses and rice bran ("darak") and the mixture is applied or mixed with bait.

SODIUM ARSENITE

Like white arsenic and Paris green, sodium arsenite is commonly used in other countries as a poison for baits for locusts and grasshoppers. As a dust it has also been found to be effective (chiefly as a contact poison) against locusts.

Sodium arsenite is also commonly employed for poisoning sugar solutions for killing ants. The amount to use is 8 to 10 grams of sodium arsenite dissolved in 1 liter of water with about ½ kilo of sugar. If available several spoonfuls of honey may be added to make the bait attractive. The bait may be put in shallow dishes or in cans with perforated covers and these placed along the paths of the ants.

SODIUM FLUORIDE

Sodium fluoride is effective against cockroaches. This should be dusted in crevices where the cockroaches are hiding or on the places frequented by them. Some of the powder sticks to their bodies, legs and antennae and when they lick themselves they accidentally swallow some of the poison.

Every precaution should be taken so that none of the arsenicals and other poisons does injury to human beings and domestic animals.

CONTACT POISONS (For the control of sucking insects, such as plant lice, scale insects, including mealy bug. See Plates 1 and 2).

Powdered soap or soft yellow laundry soap.—The amount to use is from 10 to 30 spoonfuls (levelful), in the case of powdered soap, and from 150 to 400 grams in the case of soft, yellow laundry soap, for every petroleum canful of water.

The powdered soap can be dissolved by stirring vigorously. The ordinary laundry soap can best be dissolved by boiling. A pump with a good nozzle that will deliver the spray in a fine mist should be used. The parts of the plants affected should be wetted thoroughly so as to be sure the insects are moistened. The soap solution enters the breathing organs of the insects and thus kills them by suffocation and possibly, injury of the breathing organs and blood cells.

If biting insects are present, lead arsenate may be added, at the rate of 6 to 12 spoonfuls (levelful) to every petroleum canful of the soap spray. The solution should be stirred well, before and often, while spraying. The solution will also kill ants and other biting insects, if made strong enough. Soap solutions have been found effective against the hoppers of the migratory locust, coconut leaf miner beetles, (*Promecotheca cumingi*), mango hoppers (*Idiocerus clypealis* and *Chunra niveosparsa*), etc. For the last named insects 4 to 6 grams of soap per liter of water (or an average of 1/10 kilo per petroleum canful of water) have been found sufficient without apparently injuring the mango flowers.

Plants that are flowering had better not be sprayed until one has tried by repeated trials that the soap spray, or any other spray, does not injure the flowers.

KEROSENE EMULSION

This is one of the commonest insecticides for sucking insects and is easily prepared.

Formula:

Kerosene	8 liters
Laundry soap	0.3 kilo
Water	4 liters

A petroleum can can be conveniently used for preparing the emulsion. The soap should be cut into small pieces and dissolved in the water by boiling. After the soap has all been dissolved, the can should be taken out of the fire and the kerosene added little by little and at the same time stirring the solution vigorously. A bucket pump is best used for the purpose. The liquid should be continuously pumped back into the can until the soap and kerosene are well emulsified—that is when a uniform white, creamy liquid has been obtained.

For spraying against plant lice and other sucking insects, one part of the stock solution to 8 to 16 parts of water by volume may be used.

Lime sulphur.—This is used for controlling scale insects, mites, and lichens. However, it will also control plant diseases, such as leaf spots on fruit trees, etc. Although lime sulphur is chiefly used as a contact poison, it has also repulsive effect against certain insects and other pests.

A formula for preparing ordinary self-boiled lime-sulphur is as follows:

Unslaked lime	2.5 to 0.3 kilo
Sulphur (pulverized or ground sulphur	2.5 to 0.3 kilo
Water	20 liters (about one petroleum canful).

The lime should be slaked first by adding water little by little so as to convert it into a paste. After the lime has been slaked, the sulphur should be added immediately and the two mixed thoroughly, adding more water if necessary. Thereafter, the required amount of water or 20 liters (about one petroleum canful or 5 gallons) should be added and the whole stirred thoroughly. The liquid should be allowed to pass through a strainer before spraying.

Another formula which has been used by the Bureau in the absence of unslaked lime is as follows:

Ordinary lime (air slaked)	2 kilos
Sulphur	2 kilos
Water	10 liters

The lime and the sulphur are mixed together and the necessary amount of water is added. Then the mixture is boiled for one hour or more until a clear amber colored liquid is obtained. The water that has been lost during boiling should be replaced. Then straining follows in order to free the liquid of any particles which may interfere with the spraying. The residue or lime-sulphur sludge is good for painting trunks of trees for the treatment of "gummosis" and as a repellant against bark borers. If a Beaumé hydrometer is available, the reading for the stock solution should be taken and the dilution for spraying should be made in accordance with the reading.

In the absence of a hydrometer, however, one part of the stock solution may be diluted with 20 to 30 parts of water by volume.

Lime sulphur should not be mixed with soap solution spray, as the two form a precepitate which will clog the nozzle of the spray pump.

Dry lime sulphur (*powdered or dry form of lime sluphur*).—For controlling scale insects, mites, lichens and plant diseases, particularly those attacking the leaves, shoots and fruits.

From 7 to 15 spoonfuls (levelful) per petroleum canful of water are usually sufficient. Directions are given by the companies selling the dry-lime sulphur powders. The sulphur powder should be added to the water little by little and the latter should be stirred vigorously while the sulphur is being added in order to dissolve the chemical. A good pump as in the case of fungi-bordo should be used. Spraying may be done at least once a month or as many times as the case may require. Calcium arsenate may also be added if the plants are at the same time attacked by biting insects, using from 10 to 12 spoonfuls (levelful) of the chemical for every petroleum canful of the lime sulphur spray. *Soap and lime sulphur* should not be mixed.

Carbolineum or lime sulphur sludge.—For the control of bark troubles due to insects and fungi the affected parts should be scraped off and cleaned and then painted with carbolineum or lime sulphur sludge. Lime sulphur sludge is the residue that is obtained in the preparation of ordinary lime-sulphur concentrate. *Carbolineum* should not be applied *on fresh tissues or unaffected parts.*

DERRIS

For the control of both biting and sucking insects other substances may be employed. One of these is derris. Certain manufactured compounds are available. However, fresh derris or "tubli" roots may be employed. One-half to one kilo of fresh derris roots is used for every petroleum canful (5 gallons) of water. The roots should be pounded and then soaked in the water for at least three hours, better overnight. The infusion should be strained before it is used.

Dried or fresh derris roots may be used against certain caterpillars and plant lice on cabbages, pechay and other leaf crops. To increase the effectiveness of the spray, soap should be added as a sticker or spreader, using at the rate of 3 to 5 grams per liter of the derris spray.

Derris powder is now available at the Bureau of Plant Industry, Manila. This can be used for dusting and spraying not only against plant lice but also against biting insects, such as cabbage caterpillars (with the exception of the common cutworm, *Prodenia litura*) leaf eating beetles, locusts, grasshoppers, etc. Derris dust is preferable to arsenicals, for it is not poisonous to humans when ordinarily employed as an insecticide. Fine derris dust containing about 3 per cent rotenone is used as a spray at the rate of 2 to 6 grams per liter

of water or of soap solution (or ½ to 1½ spoonfuls per liter or 10 to 25 spoonfuls, levelful, per petroleum canful of water or of soap solution).

Derris dust is also effective against fleas. It should be dusted and rubbed in on the bodies of dogs or cats infested. It may also be dusted on infested premises.

Pyrethrum.—Pyrethrum insecticides are made from the flowers of certain chrysanthemums. They are very effective against plant lice, certain caterpillars and other insects, such as mosquitoes, bedbugs and ants. For ants in the house, pyrethrum is most recommendable, as there is no danger of poisoning persons.

Pyrethrum powder is obtainable from local drug stores under certain trade names.

Tobacco water or decoction.—This is sometimes used against aphids, if nothing better is available. It is prepared by simply soaking enough wasted tobacco, such as tobacco stems, midribs, leaves or dust, etc., in water, hot water being preferable, until a decoction with the color of strong tea is obtained. The decoction is then strained, if necessary. For spraying, one part of the decoction to 5 to 10 parts of water by volume is used. The dilution may be made less if desired. It will give better results if used with soap, using from 4 to 6 grams of this for every liter of the diluted decoction (about ¼ pound of soap to one petroleum canful of the diluted decoction is enough).

Nicotine sulphate.—Nicotine sulphate, a commercial preparation from tobacco, is a powerful contact poison especially for aphids or plant lice. It is used extensively by florists and gardeners in the United States. This insecticide, 40 per cent strength, is usually used for aphids in the proportion of 1 part to 800 parts of water. For other pests such as scales and mites the amount of nicotine sulphate may be increased.

It will give better results if it is used with soap, Chinese yellow soap, for example, as a spray. A good mixture for dusting vegetables can be prepared by mixing nicotine sulphate with ordinary lime. Fine starch, such as "gawgaw" can also be used.

FUMIGANTS (For both biting and sucking insects)

Carbon bisulphide and calcium cyanide.—For fumigating grains and other stored products, carbon bisulphide is effective and this is used at the rate of 10 to 20 pounds (approximately 3.7 to 8 liters) of carbon bisulphide for every 1,000 cubic feet of room space or volume. The "bodega" should be air-tight

so as to prevent the escape of the gas. *Care must be taken not to inhale the gas as it is poisonous.* It is also inflammable, so one must be cautioned against fire. Smoking should be prohibited during fumigation.

Calcium cyanide, which is in the form of powder, flakes, granules, etc. (commonly known as "Cyanogas"), may also be used for fumigation. This is employed usually at the rate of ¾ pound to 2 pounds for every 1,000 cubic feet of room space or volume. The chemical gives off hydrocyanic acid gas, *which is highly poisonous and should not be inhaled.*

Fumigation is employed against pests of stored products, fruits, plants and other materials, but an air-tight comparment is necessary to be successful.

Carbon bisulphide and calcium cyanide are also good for getting rid of ants or termites that have their nests in the ground. These chemicals are injected or introduced into the nests to kill the queens and young. They can also be used against root grubs and other soil insects.

For "bokbok" (*Bostrychids* and *Scolytids*) and "anay" (termites) that live in wood (dry wood termites) an admixture of paradichlorobenzene and kerosene is good. This has been employed by the Bureau for many years with satisfactory results. The amount to use is 200 to 250 grams paradichlorobenzene to every liter of kerosene. Let all the paradichlorobenzene crystals dissolve before using. The solution is good for applying into wood or furniture that is infested. A syringe or a medicine dropper may be employed in applying the solution.

Paradichlorobenzene crystals may be used as fumigants, especially against insects attacking herbaria, clothes, etc. Compared with carbon bisulphide and calcium cyanide paradichlorobenzene is practically harmless to human beings.

Another fumigant consists of a mixture of carbon tetrachloride (one part) and ethylene dichloride (three parts), by volume. Twelve to fourteen pounds of the mixture are usually used for every 1,000 cubic feet. This mixture has an advantage over carbon bisulphide in that it is *not inflammable.*

Other compounds that may be used for fumigation are nicotine, chlorpicrin, chlorine, etc.

The duration of exposure varies with the materials. In fumigating seeds, household materials, dried plant materials, etc., the exposure is usually from 24 to 48 hours. Plants and plant materials that are susceptible to injury are usually exposed

for one hour and for these hydrocyanic acid gas is preferable.

REPELLANTS

As the name suggests, repellants are substances that are used for keeping away insects. The very odor of some of these repellants drives the insects away. Among the substances commonly used as repellants are tobacco dust, wood ashes, creosote, crude oil, petroleum, tar naphthaline, lime, etc. Some of these, as tobacco dust, crude oil and petroleum, also fall into one of the classes of insecticides already considered—the contact insecticides. Tobacco dust is a good aphicide or contact insecticide for plant lice or aphids. It is also sometimes used for repelling ants, like wood ashes.

Naphthaline is very often mixed with seeds for keeping away weevils and other insects.

Creosote is extensively used in the United States as a repellant against the Chinch bug which attacks wheat, corn and other crops. It is also extensively used for treating timber to prevent the attack of termites (white ants) or "anay."

Ordinary lime is used as a repellant against slugs ("lintañg lupa") and snails. It also kills these animals. The material is to be applied along the borders of plots or fields to be protected and in places where the slugs hide.

The leaves of certain wild plants, like "alagao" (*Premna odorata*) are used locally as repellants against chicken mites. Likewise the leaves of "lagundi" (*Vitex negundo*) are employed as repellants against certain insects such as the rice bug. The leaves of the local nettle plant, "lipang calabao" (*Laportea meyeniana*) are sometimes used in houses to scare away rats.

Bordeaux mixture.—This is used for controlling plant diseases, like canker and rust and other diseases occurring on the leaves shoots and fruits. However, since Bordeaux mixture is also known to repel certain insects, such as flea beetles, directions for using it are given here. It consists of copper sulphate, unslaked lime and water. A formula is as follows:

Copper sulphate	1.8 kilos
Calcium oxide (Stone lime, unslaked)	1.8 kilos
Water	190 liters

"The amount of copper sulphate can be varied according to the formula given. The weight of stone lime should be equal to or exceed the weight of copper sulphate. The important point to

consider in regard to the materials is that good unslaked lime should be used. Bordeaux mixture cannot be prepared with air-slaked lime.

APPARATUS

Two half barrels with a capacity of about 115 liters, made by sawing in two a 230-liter barrel.
One 230-liter mixing barrel.
Two or more wooden pails.
One strong paddle, about 2 meters long.
One pair of hand scales.

PREPARATION

1. Dissolve 1.8 kilograms of copper sulphate in hot water, place in a half barrel, and add water to make 95 liters.
2. Slake 1.8 kilograms of stone lime in the second half barrel and add water to make 95 liters.
3. Mix solutions by having two operators, each provided with a bucket. Dip up equal amounts of the copper sulphate and lime solutions and pour them together, at the same rate, at a height of 6 to 90 centimeters above mixing barrel.
4. Mix the whole thoroughly by stirring vigorously.
5. Strain the mixture when putting into the spray tank.
6. Apply to the plants with a good pressure spray pump. Use as soon as made.

The preceding formula and directions for preparing Bordeaux mixture are from Reinking (Philippine Journal of Science, Vol. 13, A No. 4). There are other formulas. Smaller amounts of spray may be prepared in the proportions given in such formulas. What is important to remember is that there should not be any excess of copper sulphate, as this is liable to burn the leaves. A good test is to dip a clean knife into the spray. If the blade assumes the color of copper or copper is deposited, it indicates that there is an excess of copper sulphate and more lime should be added until the spray is neutral or slightly basic.

Dry Bordeaux mixture.—This is a very convenient substitute for ordinary Bordeaux mixture, which takes time to prepare. In view of the fact that it is in the form of powder it facilitates spraying.

Ordinarily from 15 to 40 spoonfuls (levelful) to every one petroleum canful (5 gallons) of water, depending upon the tenderness of the plant, are enough. A wooden container for the spray should be used, if possible. A half barrel with holders is satisfactory. Add the powder to the water little by little and stir vigorously to dissolve the chemical. Pumps with good nozzles should be used so as to make the spray come out in a fine

mist. Spraying should be thorough. The interval of spraying will depend upon the persistence of the disease. If the plants are at the same time attacked by biting insects, like leaf-eating beetles or caterpillars, calcium arsenate or lead arsenate, preferably the latter, may be added to the Bordeaux spray. From 6 to 12 spoonfuls (levelful) of lead arsenate for every petroleum canful of Bordeaux mixture spray may be used. *Care must be taken when plants are in flower. The flowers had better not be sprayed, unless one has definitely ascertained that the spray does not harm the flowers.*

Whitewash.—The application of whitewash on the trunks and branches of trees which will not injure the bark is known as good preventive against termites and bark and wood borers and the growth of fungi.

CULTURAL AND PREVENTIVE METHODS

The value of prevention should not be overlooked. Attention should be called to the importance of planting good, disease and pest-free seeds and of seeing to it that the soil is fertile as in this way the production of vigorous resistant plants is insured. The seeds should be disinfected or fumigated, if necessary. Suitable, resistant and high yielding varieties should be used. Manure, green manure, humus or commercial fertilizers should be applied, if necessary. Other requirements of the plants, such as moisture, light, cultivation, etc., should be attended to, *as deficiency in essential requirements will make the plant susceptible to plant pests, as well as diseases.* One should see to it that his soil is not too acidic or basic and that this is corrected. Too much water in the soil is harmful to certain plants.

One should see to it also that the plant or crop he wishes to grow is suited to the climate in the region concerned.

Good plant sanitation and cultural practices, such as crop rotation, clean culture, should be adopted. For instance, any media, such as decaying vegetable matters, rubbish piles, etc., that are conducive to the breeding of certain pests should be disposed of. The coconut black beetle or "uang" (*Oryctes rhinoceros*), for instance, thrives and becomes very destructive where there are plenty of accumulated rubbish, manure, sawdust, dead coconut trees, etc., where it can lay its eggs. Get rid of weeds, as these often harbor insects and diseases. The destruction of infested fruits will help minimize the attack

of fruit flies, fruit borers, etc. Crop rotation and crop diversification should be intelligently practised.

Sick plants should be isolated or gotten rid of. Removing parts of plants that are affected will help. Cankery or scaly leaves, for instance, should be removed. Likewise affected twigs should be properly pruned or cut off.

Certain plants or varieties of plants may be utilized as "trap crops." The proper timing of planting will also minimize, if not prevent, the attack of certain pests. Thus beans planted late in October or early in November are likely to suffer less damage from the attack of the bean fly (*Agromyza destructor* Malloch) than those planted in December or later. This is also true in the case of cotton. When planted early before the beginning of the dry season, it is likely to suffer less from insect injury.

The planting of certain flowering plants is sometimes recommended to encourage the multiplication of certain parasitic insects, for the parasites feed on the nectars of the flowers of such plants. Thus the wasp parasites of root grubs are said to be encouraged in this manner. So are those of slug caterpillars on coconut and abacá, by the planting of flowering cover crops, such as *Calopogonium.*

MECHANICAL METHODS

The use of other methods, such as handpicking caterpillars, collecting with different devices, trapping, etc., is effective in certain cases and should be employed. As a matter of fact, when these methods are timely and properly employed in certain cases, the use of insecticides, which cost money, may be dispensed with. The value of persistent collection is illustrated, for instance, by the case of the Citrus green bug (*Rhynchocoris longirostris*), which causes the falling off of citrus fruits in the Tanauan Citrus Station (Batangas). By persistent collection of the adults as well as the nymphs with the employment of nets with long handles, the pest has been kept in check there. Collecting the grubs, as well as the adults, has helped much in the control of the "toy beetle" (*Leucopholis irrorata*), the grubs of which attack sugar cane, rice and other plants (Plate 7).

The catching of locust flyers with nets and of hoppers by the corral and pit methods are effective especially in well populated provinces in Luzon and Visayas. Professional locust catchers, who sell the locust flyers in many provinces, are often of great help in wiping out locust swarms.

Light trapping, when timely employed, is also good against certain insects, such as the rice bug (*Leptocorisa acuta*), rice borer (*Schœnobius incertellus* and *Scirpophaga innotata*) and termite swarms. In order to secure the best results by the use of light traps in the control of rice borers and rice bugs, all the farmers in a locality affected should employ the method at the same time. They should begin setting up the traps early enough in order to catch the mother moths before they lay eggs on the rice plants. In coöperative control work like this, the services of the Plant Industry men in the province concerned should be availed of.

The use of tangle-foot or sticky preparations for catching and repelling certain insects is also good.

Bagging fruits to protect them from being infested by certain insects, such as fruit flies, moths, may save many a valuable crop, which would otherwise be lost if not so protected. The fruits of jackfruits ("nangka"), annonas ("ates," annona, etc.) and cucurbits ("patola," "upo," etc.), for example, can be saved in this manner. Ordinary pipe water applied with a strong pressure pump is at times effective in cleaning trees of certain insects, like plant lice and mealy bugs. Fire engines may be employed for this purpose, especially in public parks.

Flooding is sometimes employed against certain insects, such as armyworms, grubs, etc.

Fire is employed in certain cases. Thus burning grasslands is resorted to in the case of the locusts, especially hoppers. This method, however, should be used with care because of the danger of burning forests. The use of flames for killing ants is well known. Torches are sometimes used for killing certain pests, like rice bugs, mites, etc. There are in the market various devices for generating flames to kill locusts, weeds and other pests.

The use of heat to kill certain insects should be mentioned here. Steam heat, maintained at a temperature between 120° and 150° F for several hours, is often employed for killing insects affecting seeds, flour and other stored and manufactured products in grain houses, elevators and factories.

BIOLOGICAL CONTROL

USEFUL BIRDS, INSECTS AND OTHER ANIMALS

Everybody should help in the conservation and protection of insectivorous birds. Among these are the "martinez" (Chinese mynah) and the red-tailed shrike (locally known as

"cabezote," "tarat" and "pakiskis" in Tagalog; "panal," "palal" or "berdugo" in Ilocano; and "talimbalalas," "tibalas" and "tibas" in Visayan). Even the much maligned crow eats many destructive insects, more especially root grubs. Crows should not be indiscriminately killed. It is only when they are molesting poultry or destroying corn when something should be done to prevent, if possible, the limited destructions caused by them. Birds should be encouraged to nest on farms by the growing of suitable trees and providing them with houses for shelter where to nest in.

Many insects are useful, for they kill other insects, which are destructive. Indeed, parasitic and predatory insects are among our most important allies in insect pest control. Among these useful insects are the mantids and dragon flies. But by far the most important are the lady-bird beetles, which eat plant lice, scale insects and certain others. Certain wasps, the larvae of which subsist on the bodies of certain injurious insects, are equally important. Farmers in particular, should learn to recognize their friends and allies among the insects.

Toads, frogs, lizards and house bats also eat many injurious insects. It may pay to construct houses for bats, especially in large farms or "hacienda." Even pythons are beneficial for they eat rats. These animals, therefore, should not be unnecessarily destroyed. The common rice paddy frogs are edible and are caught in large numbers during the rice planting season. In view of their value as insect eaters, among the insects they commonly eat being rice pests, such as armyworms as proved by dissection by the Entomology Section of newly caught frogs, as many as twelve good sized worms having been found in one stomach, it seems advisable to regulate the catching season for frogs.

All concerned should at least also take cognizance of the importance of the work of scientifically trained men in connection with the search of parasitic and predatory insects and other useful organisms in other countries with the object of introducing the most promising of such organisms into the Philippines to control local pests, such as locusts, coconut leaf miner, cacao pod borer, etc.

LEGISLATION

The enactment of certain laws and the promulgation of administrative orders in conformity with such laws are often resorted to as a means of controlling certain noxious insects. This is necessary in order to secure concerted or collective action against such pests and to safeguard the public welfare. As an example of a law of this kind may be mentioned the Locust Act No. 2472 in the Philippines which compels all male inhabitants in every municipality from 6 to 60 years to devote two days a week (working 9 hours a day) of gratuitous service in the combating of locust whenever there is an infestation. The services of these men can be utilized to the best advantage in the systematic application of poison baits. Another law is the Plant Quarantine Act (No. 3027), which aims not only to prevent the importation of foreign plant pests and diseases into the Philippines but also to prevent the spread of those that are already doing harm to the agricultural interests of the country. A number of specific administrative order has been promulgated in accordance with this Act in order that its purpose may be accomplished. One of these is that which prohibits the importation of all susceptible fruits from Mediterranean fruit fly infested countries. The old adage "an ounce of prevention is worth a pound of cure," applies with great force in plant quarantine work.

HINTS AND PRECAUTIONS

Before any method of control is used, such as spraying or dusting, the approximate expenses and the probable profit that will be obtained as a result of the application should be carefully figured out. In the control of any pest, every practical method possible should be employed.

One should be sure that the trouble affecting his plants or crops has been properly diagnosed and that he has the right compounds or chemicals to use, if these are necessary.

One should have the proper equipment on hand, considering the kind or kinds of plants to be treated and the area involved. If one has a commercial orchard, perhaps the type he should have is a barrel pump or a power sprayer rather than a bucket pump, for the sake of economy in the long run. One should see

to it that his pumps are provided with the right kind of nozzles and other accessories and that they are properly cleaned after they are used. He should see to it also that the control measures used are timely applied and that the application is done at proper intervals, if necessary, until the pest or disease involved is controlled.

In preparing a spray, one should beware of over concentration. It is far better to make the solution or dilution weaker and increase the concentration, if it does not give the desired results, than making it too strong at once and injure or kill the plants. In case of doubt, it may be well to spray a few plants first to observe the effect of the spray both in pest or disease and on the plants, before a general or wholesale spraying is attempted.

If one fails to get the desired results with a certain method, he should *try to analyze the causes of his failure.* Perhaps he had better consult the Bureau of Plant Industry or its representative in his province, at least before employing other methods.

Care should be taken in the use of arsenical poisons and fumigants in particular, as some of them are poisonous to human beings. When not in use, they should be kept in a dry and safe place where they are not accessible to children and irresponsible persons. They should be properly labeled "Poisons", with skull and bones drawn, if possible. After a prolonged dusting and spraying work with arsenicals, one should wash his hands very well and take a bath whenever possible.

FIRST AID REMEDY

With proper care there should not be any accident in connection with the use of poisons. However, in case of accidental poisoning through the mouth with an arsenical, the patient should be induced to vomit and then given the white parts (fresh) of eggs, followed shortly by a good laxative. Then the services of a physician should be employed.

CONSULTATION

For further particulars regarding other plant pests and diseases, and sound agricultural practices in general, partly with the object of preventing the attack of pests and diseases, one may consult the Bureau of Plant Industry or its representative in his province.

If necessary specimens of the pest or disease complained about should be sent to the Bureau so that it may be identified and appropriate suggestions or recommendations as to control given. As to the necessary data to be furnished with specimens and as to the sending of these, Form No. 47 of the Bureau, copies of which may be had on request, should be consulted.

Before employing hired or professional service (which may entail considerable expense) in the control of any pests, such as white ants or termites ("anay") one may well consult the Director, Bureau of Plant Industry. The free advice and service of the Bureau may save him or her unnecessary expense. Perhaps with the information given by the Bureau about the pest—its nature, its habits, the extent of its ravages and etc.—one may apply the necessary control measures himself with local labor at considerably less expense.

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ILLUSTRATIONS

Plate 1

Fig. 1. *Sucking insects.*—Plant lice or aphids (*Aphis gossypii*) on cotton leaves. These aphids attack many other plants, such as citrus, melons, "pechay," etc. They and the other aphids can be controlled by spraying with soap solution in combination with nicotine sulphate or derris. Control work should start before they become very abundant. (After Otanes and Butac.)

2. *Other sucking insects.*—Mealy bugs (*Ferrisia virgata*) on mango fruits. They also infest many other plants, such as cotton, the different kinds of Annonas, gourds, etc. As in the case of aphids spraying with soap solution but of a stronger concentration can be used. The ants that attend to them should be destroyed. Mealy bugs are locally known as "dapulak" (Tagalog), and "aplat" (Ilocano).

Plate 2

Fig. 1. Other sucking insects of the scale insect family on Citrus. These scales (*Parlatoria siziphus*) are very destructive to oranges, lemons, etc. Contact sprays, such as soap solution and lime sulphur, should be applied regularly against these and certain other kinds of scale insects.

2. Other examples of sucking insects of the true bug family. These insects are "vacavacahan" (*Dysdercus megalopygus*) in different stages—eggs, nymphs and adults. The insects attack cotton and other related plants. They also can be controlled by means of contact poisons, such as soap and derris. (After Otanes and Butac.)

Plate 3

Fig. 1. *Biting insects.*—Cabbage caterpillars (*Crocidolomia, binotalis*). The pupal and adult stages of the same are shown. Stomach poisons, like calcium arsenate and lead arsenate, are effective against these. Derris powder can also be used.

2. A cabbage plant showing the work of cabbage caterpillars.

Plate 4

Fig. 1. Other caterpillars (*Heliothis assulta*) on tomatoes. Spraying or dusting tomato plants with calcium or lead arsenate will control them. Apply control measures early and periodically, if necessary, to get results.

2. Showing different caterpillars on mango: at the left are "bagworms"; the two following are leaf rollers and the last two

are still different. All these not only attack the leaves but also the flowers. These can best be controlled by arsenical poisons. However, certain contact poisons, like derris, may also prove effective and should be tried.

PLATE 5

FIG. 1. *Another chewing or biting insect, a beetle.*—The coconut leaf miner, *Promecotheca cumingi,* and portions of coconut leaflets showing injuries by adult beetles and larvæ.

2. *Another biting insect.*—A weevil, the sweet potato weevil, *Cylas formicarius,* and the injury by it and its larvæ or grubs in a sweet potato tuber.

PLATE 6

A national menace.—The Oriental migratory locust (*Locusta migratoria manilensis* Meyen), another biting insect. Fig. 1 shows the different stages, egg, nymphs or hoppers and adult flyer. Fig. 2 shows the manner of laying eggs in the soil. From the date the eggs are laid to the time the insects become flyers takes about 70 days. Locusts as pests can not be entirely eradicated, but with sufficient funds their numbers can be greatly minimized by killing them in their breeding grounds, especially with the use of poison bait and arsenical dust. (Bureau of Agriculture illustrations.)

PLATE 7

Other biting insects, toy-beetles ("salagubang"), *Leucopholis irrorata,* and their grubs and pupæ. The grubs are among the most important pests of sugar cane, upland rice and other crops and the adults feed on the leaves of mango and other fruit trees. The pest can best be controlled by encouraging the multiplication of its parasites and killing grubs by means of poisons, such as carbon bisulphide, lead arsenate, etc. Collecting the grubs and the beetles by community efforts is effective. (After Otanes.)

PLATE 8

FIG. 1. Spraying with a compressed air sprayer, which is very handy and very convenient for plant pest and disease control in nurseries and flower and vegetable gardens.

2. Spraying mealy bugs on shade trees with a barrel pump. An apparatus like this is equally good for spraying fruit trees. Note the elevated platform built on the cart so the operators could properly spray all parts of the tree—a device likewise recommendable for orchards.

PLATE 9

An illustration of dusting with an ordinary hand duster (at left) and spraying with an ordinary bucket spray pump (at right). Note the long rubber hose provided and the advisability of tying the terminal portions of the hoses to long poles to reach the parts desired to be sprayed. (Bureau of Agriculture cut.)

PLATE 10

FIG. 1. Dusting vegetable beds with a contact poison dust (nicotine dust) to kill flea beetles by means of a bottle with "sinamay" cloth to allow the dust to pass through and in a regulated manner.

2. Showing method of dusting grassland with calcium arsenate by means of an ordinary rice gunny sack to kill armyworms (*Spodoptera mauritia*). In the absence of ordinary dusters, local devices, such as this, may be resorted to.

PLATE 11

Spraying coconuts with soap solution by means of a power sprayer to kill leaf miner beetles. The whole apparatus is mounted on a cart and drawn by a tractor. Power sprayers are recommendable for use in commercial orchards and city parks. They may be mounted on carts or trucks.

PLATE 12

Some examples of beneficial insects, our allies in the control of pests among the insects. A small wasp parasitic on caterpillars, figure 1. Figure 2 shows a caterpillar with the eggs of this parasitic wasp, as indicated by the arrows; figure 3 shows a dead caterpillar with the larvæ of the parasites underneath; and figure 4 shows a full grown larva of the wasp. All figures are greatly enlarged. Figure 5 shows a bug which preys on boll weevil adults and mealy bugs and figures 6 and 7 show two kinds of ladybird beetles which prey on plant lice and perhaps mealy bugs also. (After Otanes and Butac.)

(Figs. 1 to 4, inclusive, are *Euplectrus manilæ* Ashm.; fig. 5 is *Geocoris tricolor* and fig. 6, *Chilomenes sexmaculata*.)

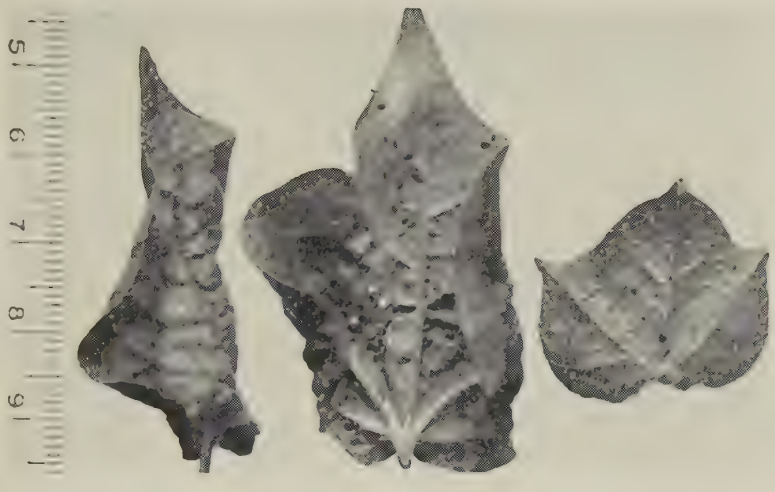

PLATE 1.

PLATE 2.

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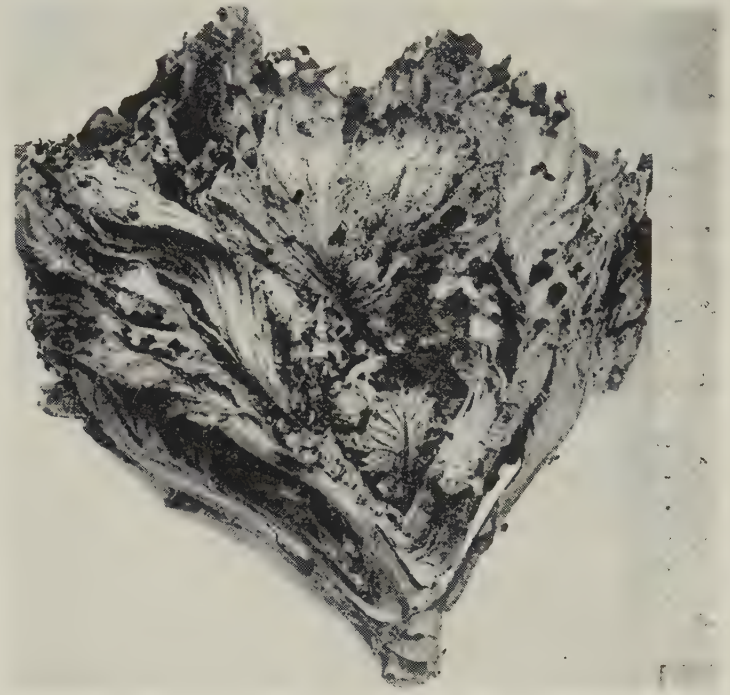

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PLATE 3.

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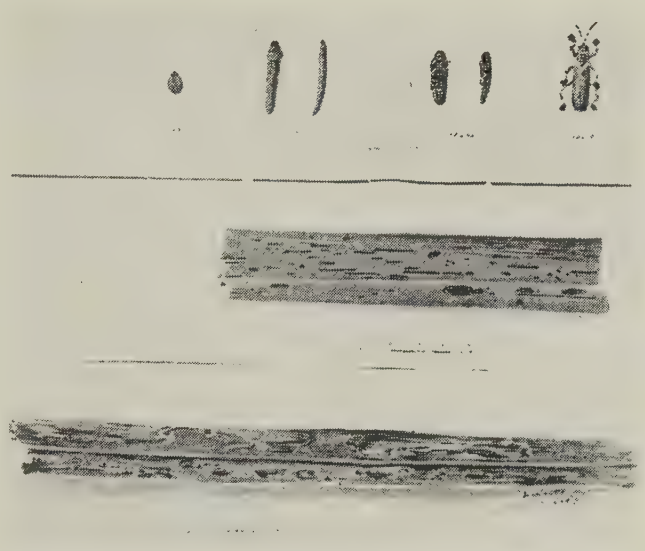
PLATE 4.



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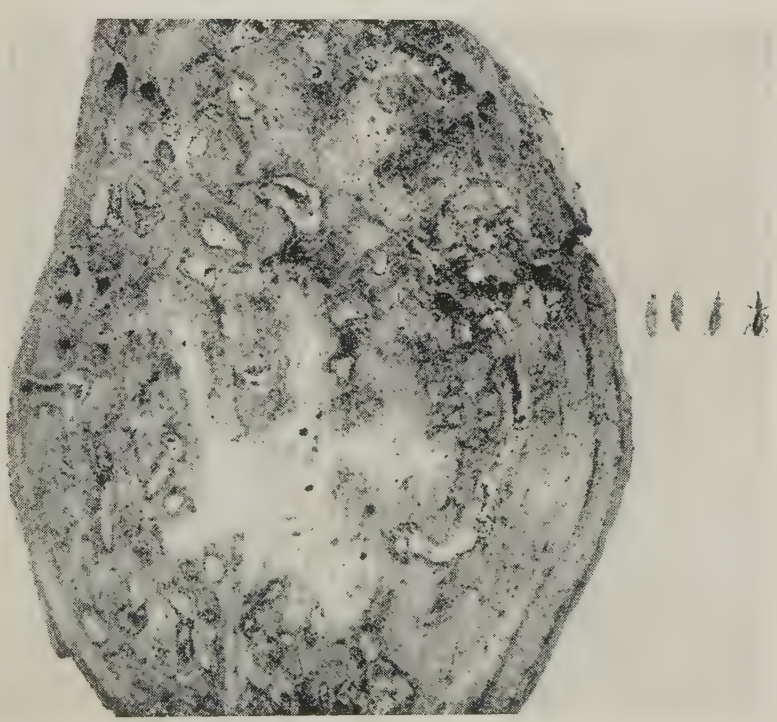

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PLATE 5.

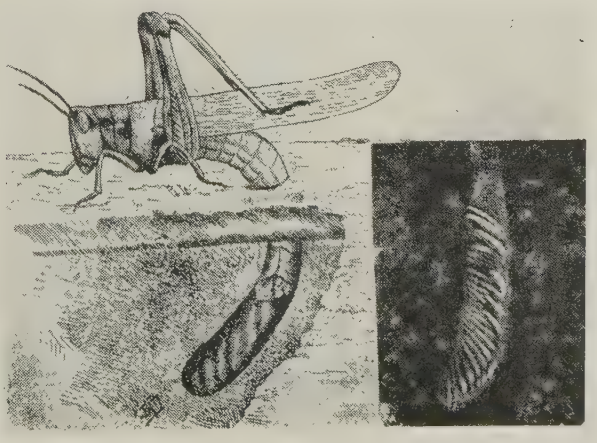

PLATE 6.

PLATE 7.

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PLATE 8.

PLATE 9.

PLATE 10.

PLATE 11.

PLATE 12.

THE RICE BUG AND ITS CONTROL[1]

Dialect Names: Atangia (Tagalog); Tiango, Piangao (Visayan); Dangao (Ilocano, Ibanag, Zambal); Dangeo (Pangasinan); Dongo (Pampango); and Tayangao (Bicol).

Farmers' Circular 30

By F. Q. Otanes
Of the Bureau of Plant Industry

ONE PLATE

The rice bug is one of the worst insect enemies of rice in the Philippines and other Asiatic countries. Farmers are so familiar with it that it is not necessary to describe it here.

The rice bug is destructive chiefly to varieties of rice that are planted early and which bear panicles late in September, during October or early in November. It has also been found destructive to varieties of rice planted during the dry season in places where dry season planting was not practised before, as in Pangasinan. One reason for such great damage is that there are only relatively small plantings of such varieties and all the bugs in the neighborhood being attracted there, they cause great damage on the crops, sometimes destroying them all. On the other hand, the injury they do to late varieties of rice is very slight, if any, per unit area, one reason being that the insects spread over a wide territory.

The bugs suck the juices of the grains during the milk stage, their mouth parts being well adapted for this purpose. Once the kernels of the rice have formed, however, they are no longer subject to injury by the bugs. Injured grains are usually empty and of a brownish color.

LIFE HISTORY AND HABITS

During the months when rice is not growing or before any rice panicle appears, the insects feed and breed on wild grasses, but as soon as rice heads are available, the insects migrate to them as these are their favorite food.

[1] Issued formerly as Circular No. 160 of the defunct Bureau of Agriculture.

Some farmers seem to believe that the rice bug together with other insects is engendered by the air rising from the soil instead of being born like other creatures, and are greatly surprised when shown egg masses and told that the bugs will come from these.

The eggs are dark reddish brown in color and are usually laid in groups of more or less regular rows consisting of one or two eggs on the leaves of the host plants. On rice the eggs are usually laid on the surface of the leaves a few inches from the tip. Occasionally eggs may be found on the rice panicles themselves. Since the eggs are dark reddish brown, they can be easily seen in the rice plants, once one has learned how to recognize them.

In about a week after the eggs are laid they hatch into young wingless bugs (nymphs) and these commence to feed on the host plants. The nymphs molt five times, after which they change into the winged or adult stage. The nymphal stage lasts about twenty days. The life cycle of the insect, therefore, from the time the eggs are laid up to the time the adults emerge, is approximately one month. Of course, the length of the life cycle would vary more or less in different places and is influenced chiefly by climatic factors, as temperature, humidity, etc.

CONTROL MEASURES

REMEDIAL MEASURES

1. Catching the insects by means of cloth nets or bags as is done in India. This can be easily done, for when the adult rice bugs are disturbed, they fly above the rice panicles and they can be caught with nets or bags without damage to the panicles.

2. Collecting the eggs and crushing them, or simply crushing them on the rice leaves with the fingers. It is better to collect the eggs for the resulting nymphs or young wingless bugs are just as voracious or more so than the adults. The eggs are attacked by small wasp parasites. Instead of crushing them, therefore, they should be collected and put in a bamboo tube or any suitable container and placed in a pan of water with kerosene. The object is to allow the wasp parasite of the eggs to fly and continue their beneficial work, and at the same time kill any young rice bug that may emerge from the eggs. The young rice bugs are wingless and, therefore, cannot fly. If they try to swim in the pan they will be killed because of the kerosene, and if they do not leave the container they will die of starvation.

3. Attracting them to lights at night. Large numbers can be exterminated by building fires near the paddies or on the dikes, or by burning bundles of bamboo sticks and going through the paddies with the burning bundles. The insects fly into the flames and are killed. Lanterns over basins containing water, to which has been added some kerosene or crude oil in order to cover the surface of the water, may be used. The stronger the light the better. In this method there is the cost of equipment and oil to consider. Light traps are most effective when there is no moonlight.

If these three methods are employed persistently from the time the first panicles appear up to the time the grains have already hardened, when they are no longer susceptible to attack, there will be little damage done by the rice bugs.

PREVENTIVE MEASURES

1. During the months when there is no rice or before the rice panicles appear, the bugs feed and breed on weeds, especially grasses. These are the right periods to kill the bugs. Clean cultures should be the rule. Destroy all weeds that serve as hosts for the bugs. Where the bugs are found abundant on these leaves, one good method is to cut these weeds leaving only a small area so that the bugs will gather there. They can then easily be caught with nets and killed, or sprayed with either soap solution and derris or dusted with derris as directed in this circular.

The land should be thoroughly prepared before the rice is planted in order to get rid of the weeds as much as possible. The essential requirements of the crop as to fertilization, irrigation, etc., should also be properly attended to.

2. As has been stated, the bugs are destructive chiefly to early varieties of rice. It is, therefore, suggested that either the planting of these early varieties be stopped, since they serve as breeding places for the bugs and may thus enhance the danger of their doing considerable damage to the late or regular season varieties of rice, or that the time of planting should be so regulated that these early varieties will flower at the same time as the late varieties. In this way the bugs will not concentrate their attack on any single field.

3. Dr. L. B. Uichanco, of the College of Agriculture, Los Baños, Laguna, observed that non-aromatic and bearded varieties of rice are less susceptible to the attack of the bugs. Other things being equal these varieties should therefore be planted

in preference to others. Observations should be made in each locality to find out what varieties of rice are entirely free from the attack of the pest.

The eggs and the bugs are preyed upon by other insects. These, therefore, are of help in the control of the rice bugs.

Although there are other methods that can be used to combat the insects, as spraying and dusting with chemicals, these methods should be used with caution because of the expenses involved. Chemicals should be employed at first under expert advice and supervision. One of these methods is spraying with soap solution, the amount of soap to use being one-fifth to one-third of a kilo to every petroleum canful of water. A one-man compressed or knapsack spray pump with a good nozzle is especially good for spraying. Care should be taken that the insects are well moistened with the spray.

A very effective remedy against the bugs is derris (tuble) dust. This is used at the rate of 2 to 6 grams or $\frac{1}{2}$ spoonful to $1\frac{1}{2}$ spoonfuls per liter of water (10 to 25 spoonfuls, levelful, to every petroleum canful of water). It is better if the derris is used with soap at the rate of 5 to 10 grams per liter of water ($\frac{1}{10}$ to $\frac{1}{5}$ of a kilo).

Dusting with derries dust is also effective, but to get the best results, a good duster which can be bought from hardware store should be employed. Of course, an ordinary rice sack or a "sinamay" bag may be used, but the dusting would not be satisfactory, and a considerable amount of the dust is likely to be wasted.

Another method (a method recommended by the old Bureau of Agriculture) is attracting the adult bugs with decaying substances, such as rotten meat. This is put in a "sinamay" bag and is hung up in the infested field. The bugs gather on the bag to suck the juices of the rotting meat. They can then be killed by catching them with nets or by any other method which will not destroy or affect the attractiveness of the bait.

Instead of rotten meat, rotten fish, shrimps and mollusks have been employed in some places.

ILLUSTRATION

PLATE 1. The rice bug

FIG. 1. Egg, side view.
2. Egg cluster on rice panicle.
3. First instar.
4. Fifth instar.
5. Adult.

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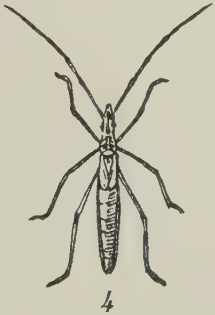

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PLATE 1.

RICE STEM BORERS AND THEIR CONTROL

Local Names: Accip na Pula or Apayang Pula (Tagalog); Guetaguet (Pangasinan); Igges ti Kayo Oenno Puon ti Pagay (Ilocano); Tomasoc (Visayan).

Farmers' Circular 31[1]

By F. Q. Otanes

Of the Bureau of Plant Industry

ONE PLATE

One of the most important pests of rice not only in the Philippines but also in other countries in the Orient, such as India, Japan, Burma, etc., is the rice stem borer—*Schoenobius incertellus*. As its name indicates, it injures the rice plants by feeding within the stalks, and is difficult to control by the application of poison. Since it can transfer from stalk to stalk, it is capable of destroying a considerable number of stalks before it reaches maturity. In the earlier stages of the growth of the plants, the injury results in the death of the youngest leaves, the entire stalk gradually drying up and becoming somewhat reddish. It is for this reason that the trouble is known in the Provinces of Bulacan, Laguna and Cavite as "Accip na Pula" or "Apayang Pula." The name in this case refers to the most noticeable symptom and not to the cause, the caterpillar. At bearing time the most characteristic indication of the attack of the pest is the presence of empty white heads or panicles. These heads can be easily pulled off as they have been severed by the caterpillar from the mother plants.

The moth is pale yellow in color with a black dot at the middle of each of the outer or front pair of wings, and is about one centimeter long and with a wing expanse of from 2 to 3 centimeters, depending upon the sex.

The moths lay their eggs in clusters usually on the upper surface of the leaves of the rice a few inches below the tip. They are brownish yellow in color because of the hair covering from the abdomen of the female. It is not difficult therefore

[1] Issued formerly as Circular No. 159 of the defunct Bureau of Agriculture and Plant Industry Leaflet No. 7.

to see them on the leaves of the plants. The number of eggs in an egg cluster varies from 36 to 96, according to observations made by A. Rowan at the College of Agriculture, Los Baños, Laguna. Some farmers seem to believe that the caterpillars are engendered by the air rising from the soil instead of being born like other creatures and are greatly surprised when shown egg masses and told that the worms come from these.

The eggs hatch about nine days after they are laid. The newly hatched worms, which are less than 2 millimeters long and rather blackish, wander about and bore into the stalks of rice and feed within them, becoming pale yellow or light green after feeding for some time. In about two months, the caterpillars reach their full size, which is about 2.5 centimeters. They then transform into pupae, the resting stage, and remain as such for nine days, after which the moths emerge from the stalks thru holes made by the caterpillars before they pupate. The pupa is light brown and is about 1.5 centimeters long. The life cycle of the insect, then, from the time the eggs are laid to that when the moths emerge, is about three months.

Another species of rice borer is a white moth of about the same size as *Shoenobius incertellus*. It is known in science as the *Scirpophaga innotata*. It has essentially the same habits as the former.

CONTROL MEASURES

The following methods may be employed to get rid of the rice borers described here:

1. Collecting the eggs and crushing them. This is the best way and is practised in Japan. The importance of this method can at once be appreciated when the fact is taken into account that there are on the average about 60 eggs to a cluster. The farmers should begin to look for the eggs in the seed bed. Instead of destroying the egg clusters they should be placed in a suitable container, such as a can or a bamboo tube. This should be placed in a pan of water to which kerosene has been added. The object is to allow the parasites that emerge to escape and starve out any rice borer larvae that may develop.

2. Collecting the infested stalks and burning them will also help to reduce the damage. Care should be taken to cut the stalks at the very base so as not to miss the worms.

3. Trapping the adult moths by means of light may also be tried. A lantern set in a pan or basin of water to which has been added kerosene sufficient to cover the entire surface with a

film of oil is best. The moths are attracted by the light, the more so when it is brighter, and fall into the basin and are drowned. This method involves some expense, however. Light traps should be used timely, that is, when moths are present and abundant and before they are spent or before they have laid all their eggs.

4. Clean culture should be widely practised by farmers. All grasses that may harbor the moth and which may serve as hosts should be destroyed. The rice stubbles should be destroyed so as to kill the pupae.

5. The more vigorous the plants the more they are able to resist the attack of the pest. The paddies should be thoroughly prepared so as to destroy all the weeds. Fertilization, if necessary, should be practised, and other essential requirements of the rice plants, such as sufficient supply of water, should be attended to. Selected seeds of high yielding varieties should be used.

6. In some places in the Philippines, as in Cebu, finely chopped derris (tublé) roots are scattered over the infested paddies. The toxic or poisonous substances present in the roots are dissolved in the water in the paddies and it is supposed that when the caterpillars, on coming in contact with the water, as when they swim from plant to plant, they are poisoned and killed. Athough the alleged effectiveness of this remedy has not been thoroughly investigated, yet this method is being included here so that in places where derris roots can be obtained in abundance the farmers may try it. It may also be employed against the "rice case worms" or caterpillars, locally known as "Accip na Pute" or "Apayang Pute" (Tagalog) and "Cutalo" (Ilocano) and in science as *Nymphula* sp. Derris dust or powdered derris roots may also be employed. Derris dust (analyzing or containing about 3 per cent rotenone) has been found effective by the writer against many insects including rice case worms and the migratory locusts, both hoppers and flyers. The use of derris dust has also been recommended for the rice bugs or "atangia" (see Farmers' Circular No. 30). One advantage of derris is that it can be handled and applied by farmers without danger of being poisoned—unlike arsenical compounds which should be handled with the utmost care.

ILLUSTRATION

PLATE 1. The rice borer

FIG. 1. Egg mass on rice leaf.
2. Larva or caterpillar.
3. Rice stem cut open showing the caterpillar.
4. Pupa.
5. Adult moth.

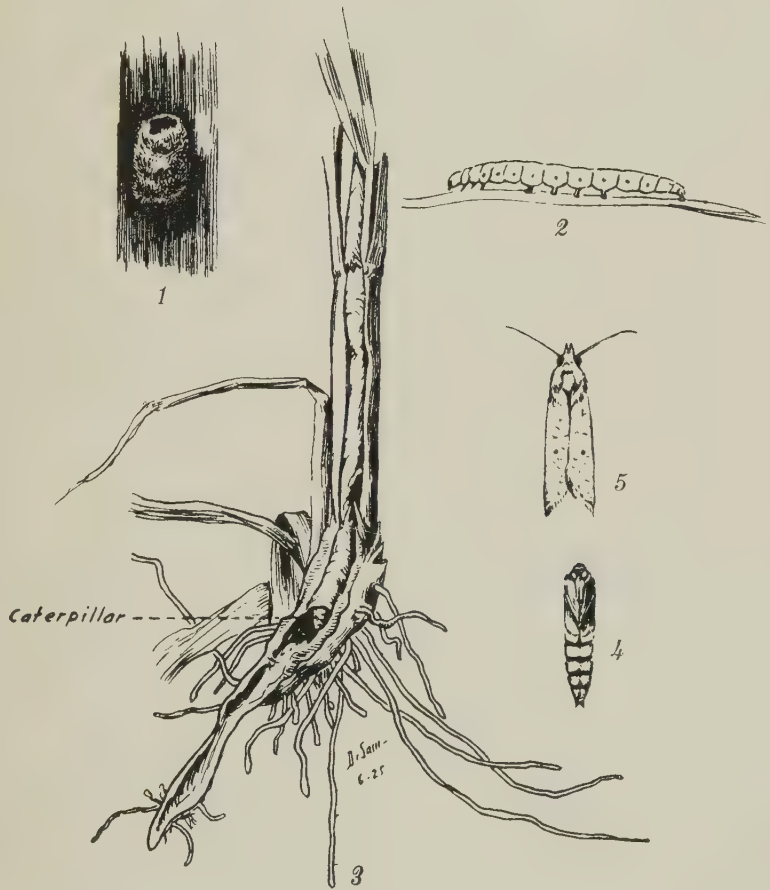

PLATE 1.

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